FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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1954

ANNUAL MEETING
June 27 - July 1

Los Angeles*

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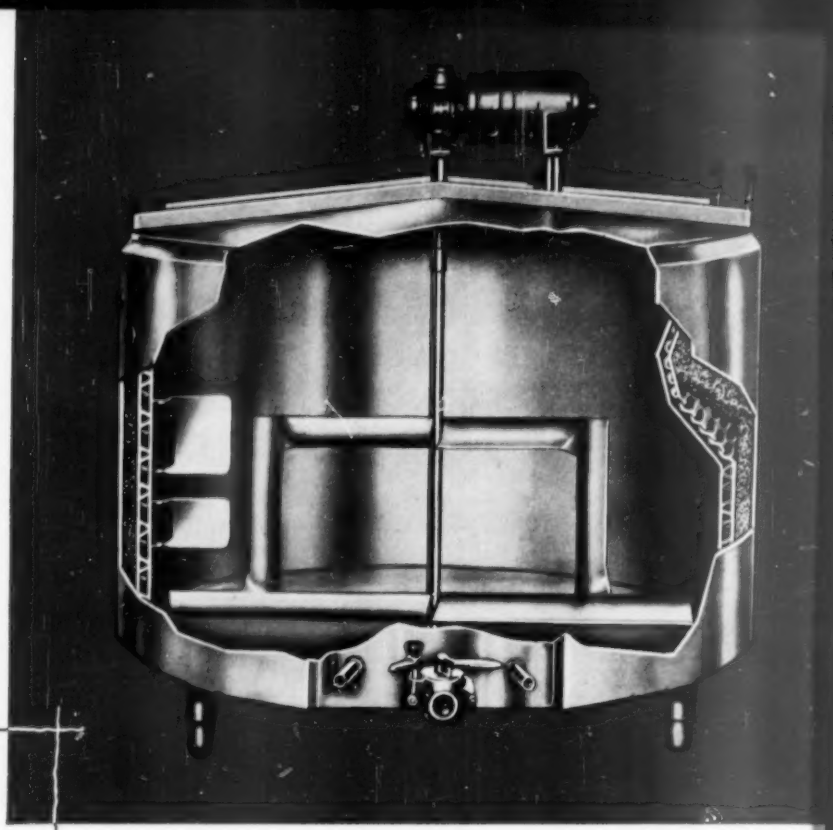

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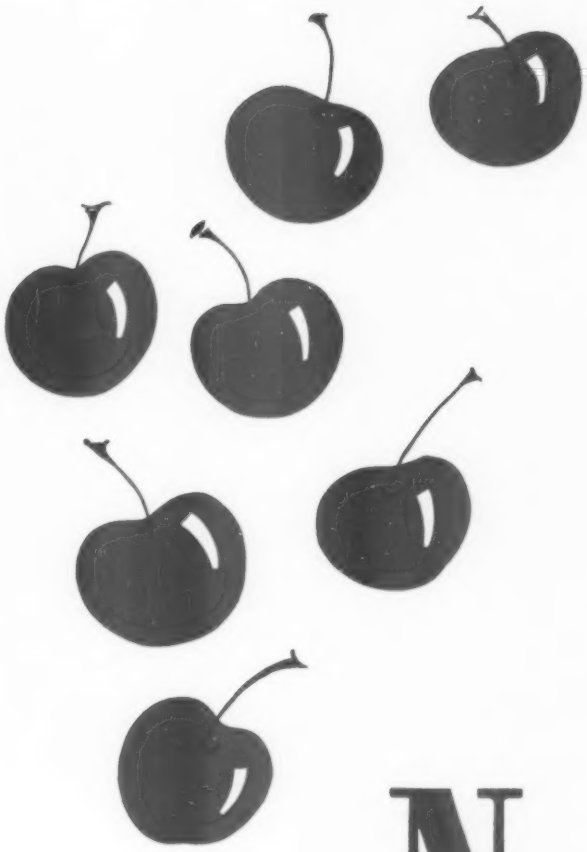

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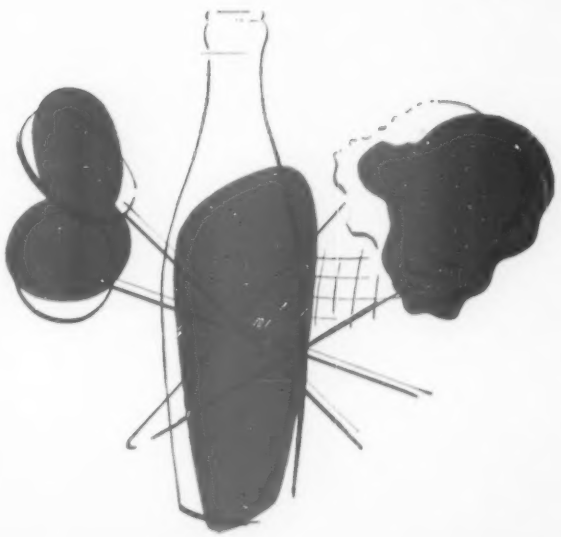

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Affairs of the Institute

Food Research: A Look at the Current and the Forthcoming Issue
News of the Regional Sections
Personnel
Books
Selected Abstracts
Annual Meeting Bulletin Board
Future Dates for Food Technologists
Food Industry Topics

FOOD RESEARCH: A LOOK AT THE CURRENT AND THE FORTHCOMING ISSUE

The Institute of Food Technologists grows steadily and evenly in membership and with this growth an increasing number of good manuscripts are coming in to our journals and, after careful review, attaining publication. Counting the March issue, FOOD TECHNOLOGY has published 176 pages of technological information relating to the production or evaluation of food products. With the issuance of the January-February issue of FOOD RESEARCH, which contained 162 pages of research data gleaned from studies of food constituents, food additives, microbiological contaminants, etc., the Institute contributed during the first quarter of 1954, some 338 pages of useful information to the fund of scientific knowledge of foods.

The nature and scope of FOOD TECHNOLOGY subject matter is well known to our readership. Not so well known is the coverage of FOOD RESEARCH, and for this reason a brief analysis of the January-February issue and that to come (March-April) is herewith provided.

The January-February issue, which by the way is Number 1 of Volume 19, opens with seven articles which effectively circumscribe the topic, "Sorbic Acid as a Fungistatic Agent for Foods." Dr. Harry J. Deuel, Jr. (University of Southern California) and co-authors present evidence on the harmlessness of sorbic acid as a dietary component and describe its metabolic behavior. Dr. Daniel Melnick, Frederick H. Luckmann, and Chester M. Gooding (Best Foods) devote themselves to the determination of sorbic acid in cheese and cheese wrappers, its resistance to oxidative deterioration, and its mode of action in inhibiting mold. Donald P. Smith and Norbert J. Rollin (Milprint, Inc.) discuss the effectiveness of sorbic acid in protecting cheese.

Four articles in FOOD RESEARCH, **19**, (1) deal with the heat resistance of microorganisms. Dr. Finn Jakobsen, from his laboratory in Malmö, Sweden, contributes some notes on process evaluation. Tischer and Hurwicz discuss the thermal characteristics of bacterial population. Spores of *Clostridium* species P.A. No. 3679, venerable culprits, come in for attention by Pflug and Esselen. La Baw and Desrosier present interesting observations on the effect of synthetic plant auxins on heat resistance.

Andrew C. Rice and C. S. Pederson (Experiment Station, Geneva, New York) consider the bacteriology of canned tomato juice—in particular, the growth of *Bacillus coagulans*. Professor Banarjee (Calcutta, India) and his coauthors analyze the vitamin contents of germinated pulses, which are important legumes, similar to our peas and beans—widely used in Asia. C. F. Harding and J. J. Davis consider the nutrients of leaf lettuce. Bor Shiun Luh and co-authors (University of California) report on pectic substances in selected varieties of tomatoes.

H. Wang and associates (American Meat Institute Foundation and the Department of Biochemistry, University of Chicago) have provided as a climax to an outstanding issue an article describing histological and histochemical changes that occur during the dehydration of beef.

In the March-April issue of FOOD RESEARCH, now in press, dairy products will be considered from a research point of view by Daniel L. Jones, who delves into the causes of "ropy" milk, by A. Z. Hodson, who evaluates the nutritional qualities of milk protein, and by Harold Salwin, who reports on a biuret method for soluble whey protein.

Research problems in fishery products are the subject matter of two articles, one by Nikkilä and Linko, two Finnish scientists, on the denaturation of myosin in defrosting frozen fish and the other by M. J. Stansby on the composition of fresh water fish.

Sandstedt and Gates (University of Nebraska), workers in the field of starch chemistry, report data on raw starch digestion. Paul E. Christensen, a Danish scientist, presents methods of grading pectin. Carotenoids in tomatoes receive attention from J. P. McCollum, and the amino acids of organ meats are discussed by B. S. Schweigert and co-authors. The putrefactive anaerobes are not overlooked. Kaplan and associates (USDA) present thermal death time curves for these enemies of stability. Doris Larkin and co-authors report the lead, zinc, and copper contents of selected foods. Dr. R. S. Harris and co-author Henry Sherman (M.I.T.) describe the nutritive values of mono-, di-, and triglycerides. Indicating something of the growing refinements in the statistical evaluation of sensory test results, the article by Baker, Amerine, and Roessler (University of California) on errors of the second kind in difference testing will be of much interest.

No. 2 of Volume 19, FOOD RESEARCH, will illustrate once again the extensive coverage of the journal, the depth of treatment, and the wide geographical distribution of its authorship.

NOMINEES FOR NATIONAL OFFICES, INSTITUTE OF FOOD TECHNOLOGISTS

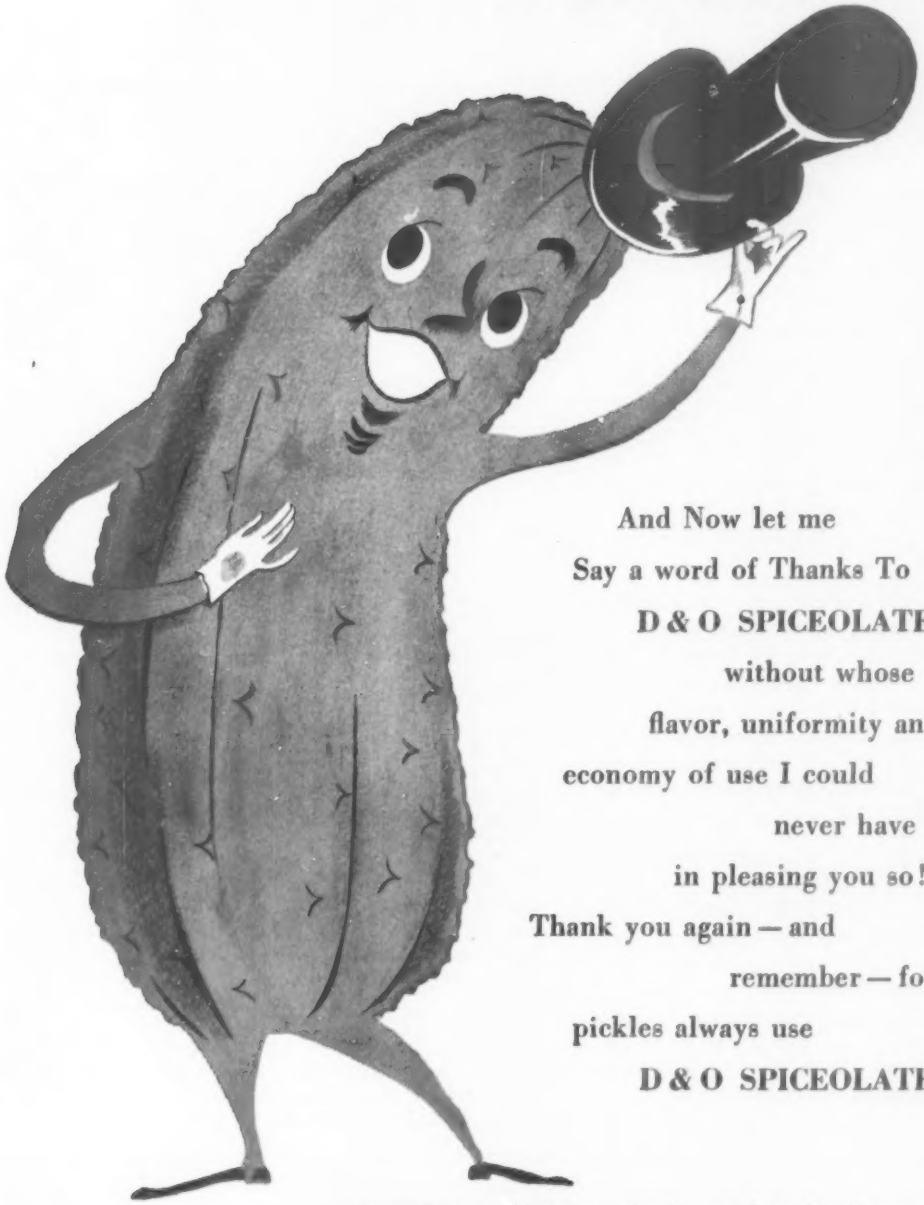
Announcement has just been made of the roster of nominees for IFT offices for 1954-55. They are:

For President-Elect: L. E. Clifcorn and Emil M. Mrak.

For Councilors-at-large: B. S. Clark; J. Avery Dunn; W. B. Esselen; Charles N. Frey; H. T. Griswold; L. A. Hall; I. J. Hutchings; Hans Lineweaver; Roy E. Marshall; and Harold S. Olcott.

THANK YOU LADIES

. . . and GENTLEMEN



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White Flour in the U.S.A.—

Enriched* with Vitamins and Iron for Better Nutrition

by Science Writer

This article is one of a series devoted to the enrichment of family white flour, white bread and rolls, corn meal and grits, macaroni products and white rice.

The enrichment of family white flour with thiamine, riboflavin, niacin and iron by American millers is a major success. It has made great contributions to better health in the United States by improving a staple food.

Since the start of the program in 1941 by millers, voluntarily, the evidence is conclusive that enrichment not only has reduced the number of cases of certain dietary diseases but also is promoting the mental and physical vigor and well-being of the U. S. population generally. Because of its demonstrated value, the principle and practice of enrichment have been applied to other foods made from grains: corn meal and grits, white rice, macaroni, spaghetti, noodles, pastina, farina—and, of course, to white bread and rolls.

Doctors and diet experts have long supported white flour enrichment. The Council on Foods and Nutrition of the American Medical Association and the Food and Nutrition Board of the National Research Council are on record as endorsing the practice.

The legislatures of a majority of the States plus Hawaii and Puerto Rico have enacted laws which make mandatory the enrichment of all family white flour, as well as white bread, sold commercially in those areas.

American homemakers, too, favor foods they know to be enriched—a fact demonstrated by surveys. They look for these words on package labels: "Enriched with vitamins and iron for better nutrition."

What Is Enrichment?

It's an axiom in the milling industry that consumers want beautifully fine, white flour. When wheat is milled and processed to get the white flour which the public demands, vitamin and mineral values are unavoidably lost.

Enrichment restores to white flour the following important vitamin and mineral factors: thiamine, riboflavin, niacin and iron. Calcium also may be added as an optional ingredient. The process is simple and inexpensive. A mixture of the vitamins and iron is fed into the flour stream during processing. This insures that the enriching ingredients are spread evenly throughout the flour.

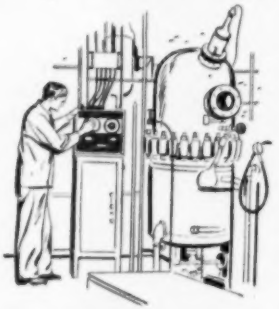
The U. S. Food and Drug Administration has established standards which white flour must meet to be properly labeled enriched. The requirements, in milligrams per pound, are:

	Min.	*Max.*
Thiamine (vitamin B_1)	2.0	2.5
Riboflavin (vitamin B_2)	1.2	1.5
Niacin (another "B" vitamin)	16.0	20.0
Iron	13.0	16.5

(In Canada, too, the same standards have been set for enriched white flour through the amendment of the Food and Drugs Act.)

Vitamins Are Made

The science of chemistry is so advanced these days that many of Nature's complex substances can be "duplicated" in the laboratory. This has happened with many vitamins. First, the chemical composition is learned. Second, the pure substance is isolated. Third, a "duplicate" is made by synthesis. And fourth, the laboratory techniques are extended to large scale operation.



The manufactured "duplicate" is identical chemically and in biological activity with Nature's own product. A vitamin is still a vitamin regardless of its source. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.

The Hoffmann-La Roche people make top quality vitamins actually by the tons. To do this they use amazingly complex processes with scientific production controls and the latest equipment which fill buildings each a city block square and many stories high.

Reprints of this article, and all others in this series are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

The watermills are gone. Today's needs require today's methods. How sensible it is that millers across the nation restore health-giving vitamins and minerals through enrichment.

*Webster's Merriam Collegiate Dictionary includes this definition of "enrich": "to improve (a food) in nutritive value by addition in processing of vitamins and minerals".

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Regional Section News

CHICAGO SECTION

Drs. William Bloom and R. E. Zirkle of the University of Chicago presented movies of their studies on the effect of ionizing radiation upon cell division at the February meeting of the Chicago Section.

Time-lapse motion pictures, made with a phase microscope, clearly illustrated the effect of radiation upon cell division. Dr. Zirkle explained techniques by which different portions of the cell could be bombarded. Only when the chromosomes were irradiated were the cells unable to undergo normal subdivision.

Eighty-five technologists observed, in repeated tests, how the radiation of chromosomes prevented cells from dividing normally and either prevented division or resulted in abnormal cells which behaved erratically. This fact casts light upon the effect of irradiation of foods to destroy microorganisms as well as the effect upon normal and cancerous tissue in radiation therapy.

Plans for future meetings were announced by program chairman John Jackson:

March 8th (Monday)—Dr. Glenn King of Nutrition Foundation.

April 19th (Monday)—H. C. Diehl of Refrigeration Foundation and past president of IFT.

May 13th (Thursday)—Milwaukee meeting at Miller's Inn.

PITTSBURGH SECTION

The 17th official meeting of the Pittsburgh Section of the Institute of Food Technologists was held in the Royal York Dining Room, February 9, 1954. As is usual at the Royal York everyone enjoyed an excellent dinner.

Several guests and new members were present and were introduced at the business meeting which followed the dinner. It was announced that the April meeting will be held on April 12th and will be known as "Ladies' Night." The wives and friends of members have been invited to attend the mixer which will precede the dinner, as well as the dinner and the meeting which will follow. We are planning to hear Mr. Art Diamond who will give a talk on "Introduction of a New Food Product."

At the conclusion of the business meeting we were honored to hear Dr. Henry Smyth, Jr., of the Mellon Institute talk on "Will Tomorrow's Food Be Safer?" Dr. Smyth gave us a most interesting and thought-provoking discussion on the safety of today's foods and present legislation and expected changes in legislation which may affect the safety of the foods of tomorrow. After Dr. Smyth's talk there was quite a spirited discussion on current and future legislation dealing with food additives, or as it has been popularly called "Chemicals in Foods." Everyone left the meeting with the feeling that today's foods are safe and that tomorrow's foods will be equally safe.

NORTHERN CALIFORNIA SECTION

Carl Austin Rietz, San Francisco food machinery manufacturer, addressed the Section's February 11th

REGIONAL SECTION NEWS

dinner meeting in Kan's Restaurant, San Francisco, on the subject: "Foods of Asia." He illustrated his talk with kodachromes taken on his recent tour. The dinner comprised a genuine Chinese 8-course banquet. Wines were furnished gratis by the California Wine Institute and Mr. Reitz.

Incidentally, the San Francisco monthly luncheons are held on the first Tuesday of every month, usually at the Old Grotto Restaurant, 545 Washington St., San Francisco. Noon 'til 1:00 p.m. All welcome.

WESTERN NEW YORK SECTION

The Section's Buffalo Area Group met on February 15 at the Erie County Technical Institute in Buffalo, N. Y. Guest speaker for the occasion was Dr. H. G. Hucker, Geneva Experiment Station, Geneva, N. Y., who spoke on "Microbiology of Frozen Foods."

NORTHEAST SECTION

The February meeting of the Northeast Section was held in the Campus Room of the M. I. T. Graduate House, Cambridge.

Dr. Hartley W. Howard, Director of Research for the Special Products Division of The Borden Company, addressed the group on the activities of commercial firms in the field of research. Speaking on the topic, "Planning Research for Profit," Dr. Howard pointed out the factors which a company must consider in setting up a commercial research project. Among these, he said, are an estimate of probable sales volume of a new product, probable operating costs, estimated production facilities, and anticipated profits.

Dr. Howard called consumer acceptance of a product "A major factor in industrial research." He discussed case histories of several Borden products in which the factor of consumer acceptance affected their commercial success. Dr. Howard also encouraged food technologists to take a "personal interest" in the legislative proposals relating to modification of the present Federal Food and Drug Laws, which may be considered in the next Congress. "If unwisely drafted," he said, "such legislation could impose a formidable barrier in the way of progress in food technology through research."

PHILADELPHIA SECTION

The regular meeting of the Philadelphia Section was held February 2 at Drexel Institute. The after-dinner speaker was Mr. E. C. Dryden, who described his hiking and bicycling trips through Pennsylvania, and gave a description of the Appalachian Trail and the Horseshoe Trail.

Dr. R. R. Baldwin, Director of the Biochemical Laboratory, Central Research Laboratories of the General Foods Corporation, delivered an address on the subject of "The Use of Isotpes in Food Technology." The use of tracer techniques as a research tool in agricultural, biological, and food chemistry was illustrated by many examples. The use of radioactive carbon in photosynthesis, for example, assists in clarifying the mechanisms of the reactions taking place within plants, since radioactivity in the products of photosynthesis may easily be detected and measured. Metabolic processes may be closely observed by feeding various food products containing radioactive isotopes as, for example, tagged amino acids to animals, and measuring radioactivity in the breath and excretions. The suitability of synthetic materials for use in food products may often be evaluated by similar techniques.

Radioactive tracers are useful in measuring the rate of penetration of water into food products in processing, storage, cooking, etc., and for observing the distribution of fats in cake batters. The evaluation of packaging materials may sometimes be facilitated with radioactivity studies.

Dr. Baldwin also discussed briefly the use of fission products, electron beams and other types of radiation in the cold sterilization of foods.

OREGON SECTION

The Oregon Section met in the evening of February 9, 1954 at the Food Technology Building on the Oregon State College campus.

The program, featuring talks by the staff members from various departments on the O. S. C. campus, was as follows:

"The Agricultural Experiment Station and Oregon's Food Technologists"—R. W. Henderson, Agricultural Experiment Station, O. S. C.

"Algae as Sources of Edible Gums and Future Foods"—H. K. Phinney, Botany Department, O. S. C.

"The Development of a Profession"—Fred Merryfield, Sanitary Engineering Department, O. S. C.

MARYLAND SECTION

Forty-three members and guests were present at the February meeting of the Maryland Section, which was held at the Stafford Hotel, Baltimore, Maryland, on Friday, February 12, 1954.

Mr. Clinton W. Woodmansee, Associate Research Professor, Agricultural Chemistry, University of Delaware, gave a most interesting and informative talk on the subject of "Pectin Research at Delaware." He paid tribute to the late Professor George L. Baker and his associates for initiating and carrying on a tremendous research program in fundamental pectin research. He carefully reviewed the history of pectin, the literature concerning pectin, and summarized the research discoveries as reported in the Delaware Experiment Station bulletins. Since many preservers and pectin producers are members of the Maryland Section, the speaker's talk was quite pertinent and well received.

ERRATUM

It was incorrectly reported in the "Maryland Section" of the Regional Section News, page 7, FOOD TECHNOLOGY, March, 1954, that the address of W. J. Hart, Jr., Section Secretary, was "Virginia Polytechnic Insti-

(Continued on page 8)

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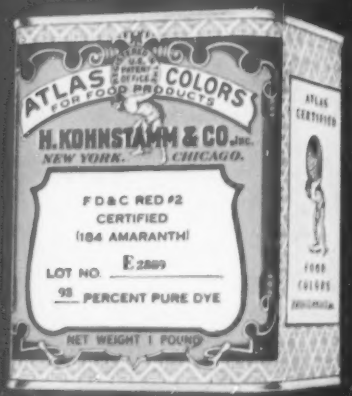

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REGIONAL SECTION NEWS

(Continued from page 6)

tute, Blacksburg, Virginia." This address was taken by the News Editor from the IFT Directory, 1949. Mr. Hart's address should have read: "Chief Technologist, John H. Dulany & Son, Inc., Fruitland, Maryland." Please accept our apologies. *News Ed.* (Incidentally, Section Secretaries are requested when reporting newly elected offices to include the position held, firm connection and firm address of these officers.)

PUGET SOUND SECTION

The Puget Sound Section so far has had three meetings during the 1953-54 year. The Section's October meeting was held on Wednesday, October 21, 1953 at the School of Fisheries, University of Washington, Seattle, with 45 members and guests present. Dr. Richard Van Cleve, Director of the School of Fisheries, was the speaker of the evening. His talk was of wide general interest to the members and guests on the subject of the role of technology in the future of our fisheries. A lively discussion period followed this talk with nearly everyone joining in. The December meeting was held at the plant of Vernell's Fine Candies, Inc., Seattle, on December 1, 1953. The management of this firm arranged to have the plant operating for the benefit of the members and guests. The manufacture of "Vernell's Fresh Buttermints" was highlighted by close attention to quality control throughout the entire candy-making operation. Following the tour, the management was host to the group at a discussion and coffee hour. Forty-two members and guests were present. The third meeting of the Puget Sound Section was held on Tuesday, February 2, in the Evergreen Room of the Student Union at the University of Washington. The speaker was Mr. John Mawson, Manager of the Alaska Native Industries Cooperative Association. Mr. Mawson gave an interesting account of the problems connected with the sending of food to the Alaska regions above the Arctic Circle. Native tastes, special packing procedures, and the problem of shipping food in the Arctic were described. Following the program, a short business meeting was held.

DIXIE SECTION

The Dixie Section built its February Meeting around "Marketing of Foods." During the afternoon a guided tour was made through the southeastern warehouse of Colonial Stores, in Atlanta, under the supervision of Jack Fairchilds. After the evening banquet J. C. Holton, Georgia Department of Agriculture, addressed the group on "Marketing Foods in Georgia." The total attendance for the day was about 75.

The southeastern headquarters of Colonial Stores serves 350 super markets in nine states. "The trend for forty years has been for larger and larger grocery stores," said Jack Fairchilds. "The super market has replaced the counter type grocery store in practically all communities of the South; and now food prices, in terms of time consumed in gathering, are lower here than in any country in the world," he continued.

The warehouse visited is the largest of five others in the south having a total annual gross sale of $230 million. They stock 1,900 food items, and would require a train 175 miles long to fill the six warehouses at one time.

The Atlanta warehouse has interior docks for 39 railroad cars which transport 48% of their merchandise. The remaining 52% is hauled by trucks for which there are even more spacious docks. The personnel and facilities are highly departmentalized and include: quality control laboratory, dry storage, refrigerated storage, freezer storage, banana ripening room, tomato ripening room, fruit prepackaging room, vegetable prepackaging room, egg candling and grading room, meat aging, cutting and prepackaging room, coffee roasting and grinding room, and a complete bakery. Nine thousand pounds of coffee are roasted three times per week in three large electronically controlled roasters.

The tendency is more towards prepackaging fruits, vegetables, meats, eggs, and bakery goods, because "we do a better job than is done in the average retail store," said Mr. Fairchilds.

A special feature of this visit was a preview of a recording of the Easter T.V. and radio show put on by Colonial Stores.

PERSONNEL

Dr. Roy E. Morse, Director of Research, announces the reorganization of the Scientific Staff of the Wm. J. Stange Co. into two major groups, Chemical and Operations. The latter, in charge of Walter A. Miller, will complete all formulations, samples and quality control. The former, under the direction of Michael J. Hickey, will handle all research, development, analytical and customer service problems.

Appointment of Arthur N. Prater, Ph.D., to vice president and technical director of Gentry Division of Consolidated Grocers Corporation, was announced recently by George E. Clausen, Gentry president. Dr. Prater became associated with the Los Angeles seasoning firm in 1945 as director of research; he is a member of the executive committee.

Dr. Lloyd A. Hall, Technical Director of The Griffith Laboratories, spoke before the Lehigh Valley Chapter of the Pennsylvania Society of Professional Engineers at the Lehigh Valley Club, Allentown, Pennsylvania, on Food Engineering—a New Scientific Profession.

Books

Biochemical Preparations, Volume 3, Esmond S. Snell, Editor-in-Chief, John Wiley and Sons, Inc., New York, 128 pages. $3.50.

This volume of *Biochemical Preparations*, the third of a series, conforms to the high standards of the preceding volumes. The Editor-in-Chief, Esmond E. Snell, is to be commended upon an excellent volume.

Biochemists have long felt the need for this biochemical counterpart of *Organic Synthesis*. As in the pre-

(Continued on page 10)

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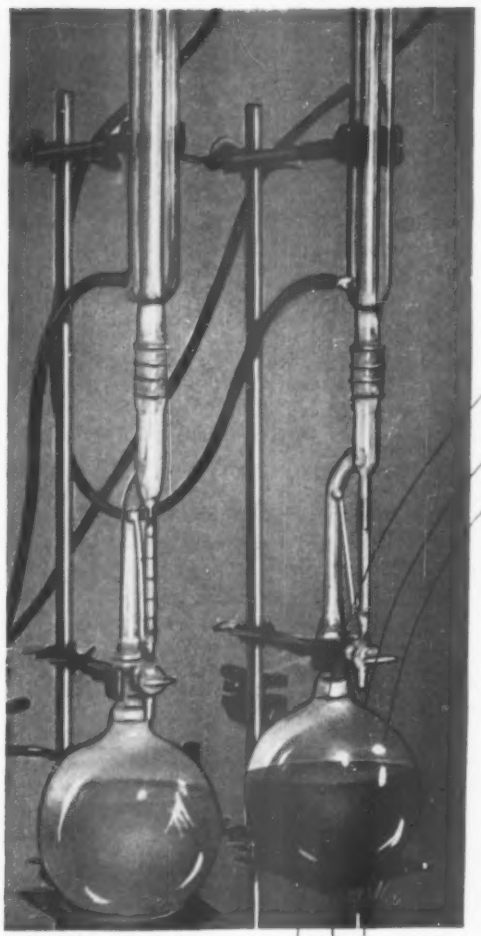

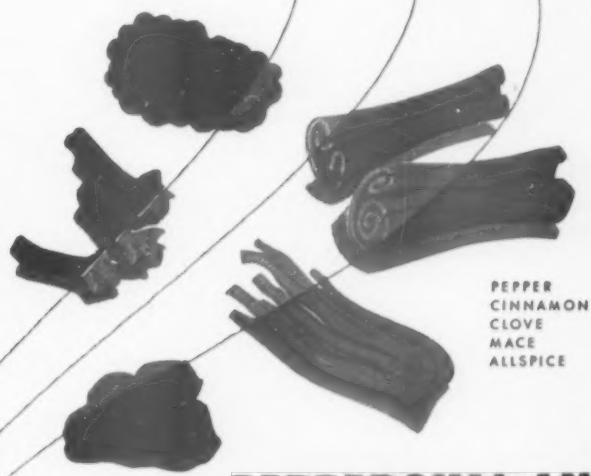

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BOOKS

(Continued from page 8)

vious volumes a list of compounds of biochemical interest which appeared in *Organic Synthesis* is given.

Methods are given for the preparation of crystalline muscle phosphorylase, ribonuclease, diphosphopyridine nucleotide, triphosphopyridine nucleotide, pyridoxamine phosphate, pyridoxal phosphate, protoporphyrin dimethyl ester, D-isocitric acid, DL-isocitric acid lactone, dihydroxyfumaric acid, oxalacetic acid, L(+) and D(—)lactic acids, sodium alpha-ketoisocaproate, D-glucose-6-phosphoric acid, D-galacturonic acid, beta-2, 5-dihydroxyphenyl-DL-alanine, L-isoleucine, D-isoleucine, L-alloisoleucine, and D-alloisoleucine, L- and DL-ornithine monohydrochlorides, L- and DL-citrulline (from ornithine), L-citrulline (from L-arginine), L-kynurenine, L- and D-penicillamine hydrochlorides, elaidic acid, and 2, 4-dinitrofluorobenzene. The methods are, of course, all checked independently by a laboratory other than that which developed them.

The biochemist will find these preparations particularly useful. Although the food scientist in general will use them only in fundamental studies of his raw materials, he may at times use them for the preparation of specific reagents such as the preparation of L-amino acids for standards in amino-acid work in food stuffs.

E. F. JANSEN
Albany, California

MORPHOLOGY AND PIGMENTATION OF CERTAIN YEASTS FROM BRINES AND THE CUCUMBER PLANT. By John L. Etchells, Thomas A. Bell, and Ivan D. Jones. *Farlowia*, IV, 3. Published by Harvard University, Cambridge, Mass. (Single reprints available by application to the authors, Box 5578, Raleigh, North Carolina).

This reprint is being brought to the attention of students, teachers, and research workers in the field of microbiology and food technology in order to attain a wider distribution for a study which "for the first time . . . brings to investigators a pictorial study of the cultural and morphological characteristics of yeasts which are found on cucumbers and in pickle brines."

Since this is a notice rather than a review, only a description of the content will be attempted. In a foreword by G. E. Hilbert and R. W. Cummings, attention is directed to the fact that some 30 species and strains of yeast belonging to 12 genera are described. The striking changes in pigmentation that result from differences in the nature of the cultural media employed are made evident by photomicrographs and in several instances by excellent color plates. The text and pictures are organized in terms of (1) the film-forming brine yeasts, (2) the subsurface brine yeasts, and (3) yeasts from the cucumber plant itself.

This study, with its 15 natural color plates, 109 halftones, and accompanying text nicely adjusted to explaining the details of the photomicrographs, is an "end-product" of one phase of a cooperative research program now in progress between the Agricultural Research Service of the U. S. Department of Agriculture and the North Carolina Agricultural Experiment Station at Raleigh. A substantial grant in funds by the National Pickle Packers Association made possible the publication of the photographic materials—including those in color.

M. S. P.

FOODSTUFFS — THEIR PLASTICITY, FLUIDITY AND CONSISTENCY. Edited by G. W. Scott Blair (Volume IV of *Deformation and Flow*, edited by J. M. Burgers, J. J. Hermans and G. W. Scott Blair), 264 pages, 90 illustrations. North-Holland Publishing Co., Amsterdam, and Interscience Publishers, Inc., New York. $7.50.

During the past few decades large-scale food manufacture has led to exacting quality and uniformity requirements. This, in turn, has resulted in the rapid development of physical control methods for foods. Many of these methods are entirely empirical while some are based on fairly well understood principles.

In the present volume some of the major developments in this field are reported, without any attempt to deal with all the major types of foods where rheological measurements have been applied and found useful. The great amount of work done on cereals and cereal products and dairy products is summarized in some detail, together with clear description and evaluation of the instruments applied. These chapters ("Starch" by Hofstee and De Willigen; "Cereals" by Greup and Hintzer; "Rheology of milk, cream, ice cream mixes and similar products" by Scott Blair; "The consistency of butter" by Mulder; and "Rheology of cheese and curd" by Baron and Scott Blair) are thorough, clear, and there is an impressive emphasis on fundamentals and theoretical considerations. The brief chapter by Pryce-Jones on "Honey" is most interesting.

Most of the material presented in these chapters is not new and much of it has been reviewed before. For these reasons this reviewer feels that the two chapters of most general interest will be the one by Harvey on "Rheology of miscellaneous food products" and that by Harper on "Psycho-rheology of foodstuffs." In a new field of inquiry such broad discussions of the principles and the attempts to classify foods from the standpoint of rheological properties are most welcome.

The indexes seem somewhat unbalanced. There is a 14-page list of "Literature," followed by a 6-page "Author Index." The 1.5-page "Subject Index" is disappointing and seems inadequate for a technical book of 264 pages. The illustrations are clear and well selected, the book is well printed, and the binding is sturdy. This is certainly a welcome addition to the food scientist's book shelf.

At some time during the past few years Dr. Scott Blair has dropped the hyphen from Scott-Blair. He may soon find himself listed among the Blairs.

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DR. LEE A. DUBRIDGE TO ADDRESS IFT MEETING IN LOS ANGELES

Dr. Lee A. Dubridge, President of the California Institute of Technology, is to be a featured speaker at the IFT annual meeting in June. Taking as his subject, "The Inquiring Mind," Dr. Dubridge will develop the theme that with the rapid increase in man's knowledge of himself, it is terribly important that we recognize the

DR. DUBRIDGE, PRESIDENT OF "CALTECH," TO SPEAK AT OPENING SESSION, 14TH ANNUAL MEETING OF IFT AT LOS ANGELES

function which the inquiring mind has played and continues to play. It is important, also, Dr. Dubridge will emphasize, that we maintain and stimulate research, improve the atmosphere in which such intellectual activities best go forward, and strengthen the institutions whose purpose it is to advance or to apply the work of "the inquiring mind."

BABCOCK AWARD BECOMES "BABCOCK-HART AWARD"

The newly adopted name, the Babcock-Hart Award, is both significant and appropriate. The Stephen M. Babcock Award of the Institute has honored a pioneer in food technology—one whose work has led to notable improvements in the nutritive quality of food as consumed by the American public. The research and educational accomplishments of the late Professor Edwin B. Hart illustrate in a similar sense the more recent progress in understanding the complexity, functions, and uses of the human food supply. These advances include emphasis upon mineral trace elements, amino acids, vitamins, and a long-term perspective in the evaluation of foods, in contrast to the relatively simple appraisal in terms of fats, proteins, carbohydrates and ash, characteristic of Dr. Babcock's day.

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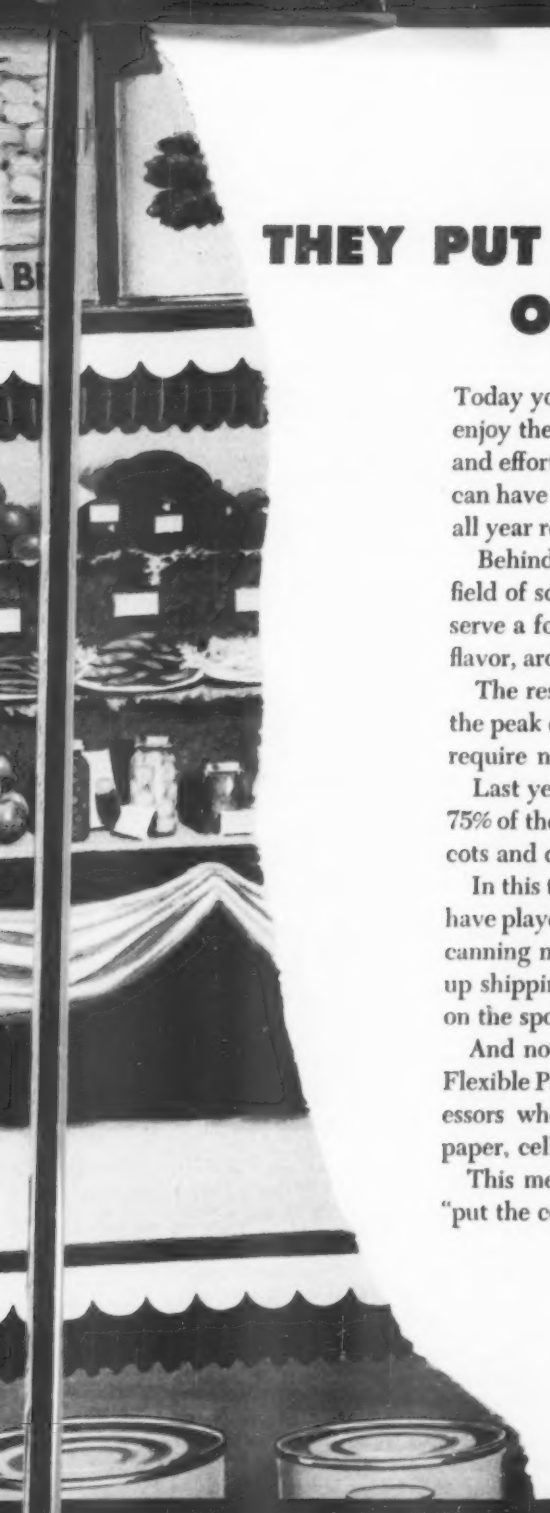

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Selected Abstracts*

ANALYTICAL METHODS

The precipitation of gelatin by ethanol, and its use in the estimation of proteolytic activity.

CREWTHER, W. G. *Australian J. Sci., Research Ser. B, 5,* 290-301 (1952); *Nutrition Abstr. & Revs., 27,* 260, No. 1315 (1953).

The conditions under which light transmission by gelatin solns. is an exponential function of the concn. were investigated. On these expts. was based a turbidimetric method of estg. proteolytic activity by ppt.g., the gelatin from buffered solns. after digestion and comparing the transmission value with a standard curve for the particular protease. For greater accuracy and for colored solns. a method is also described in which the gelatin remaining after digestion is pptd. with EtOH, centrifuged and weighed.

Another method for the determination of gelatin. II. Applying paper partition chromatography.

KAKIMOTO, D., AND KANAZAWA, A. *Bull. Japan. Soc. Sci. Fisheries, 18,* 433-6 (1953); *Biol. Abstr., 27,* 2796, No. 29460 (1953).

The gelatin content in the meat of the fishes was measured by the diln. method of paper partition chromatography. This showed the same values as the pptn. method.

Factors influencing the determination of the acetone insolubles of commercial lecithins.

STOPPER, H. R., SAFFER, B. A., AND BAUER, S. T. *J. Am. Oil Chemists' Soc., 30,* 408-10 (1953).

Data are presented from numerous analyses of com. lecithins for the comparison of values obtained from the detn. of acetone insols. by a direct weighing method against those by the A.O.C.S. Tentative Method Ja 4-46. Discrepancies introduced into these methods by the use of petr. ether as a solvent and those due to the soly. of acetone insol. compds. in the acetone ext. and wash soln. are evaluated. A proposal is made for the consideration of a direct weighing procedure for the acetone insols. content of com. lecithins whereby petr. ether is eliminated, the acetone ext. soln. satd. with pure phosphatides before use, and the insol. residue dried and weighed.

Shell content of cocoa.

JOSEPHY, G. *Mitt. Gebiete Lebensm. u. Hyg., 44,* 264-9 (1953); *Chem. Abstr., 47,* 10763f (1953).

It is shown that the phys. and chem. methods for the quant. detn. of the shell content of cocoa are unsatisfactory. Better results are obtained by microscopical estn., provided a few precautions are taken.

The determination of milk fat and coconut oil in chocolate products.

SCHETTY, O., AND VAUCHER, M. *Rev. intern. chocolat., 8,* 101-6 (1953); *Chem. Abstr., 47,* 9520d (1953).

By the semimicro butyric acid no. milk fat in chocolate products can be detd. easily, even in the presence of quantities of coconut oil as high as 30% of the mixt. of fats. Semimicro Reichert-Meissel detns. do not give const. results and are greatly affected by the presence of "cocose" (a butter substitute from coconut oil). Milk fat and coconut oil in the same products can be measured successfully by detg. the semimicro butyric acid (I) and "total acid" (II) nos., even in the presence of almond, hazelnut, and hardened arachis oils. Since duplicate detns. of I and II require only 3 g. of filtered fat, a modification of the official fat extn. method is presented whereby this quantity of fat can be obtained.

Colorimetric determination of reconstructed milk in normal milk.

REINART, A., AND BROWN, R. W. *Can. Dairy Ice Cream J., 32,* No. 6, 30-1+ (1953); *Chem. Abstr., 47,* 8920f (1953).

For the detn. of reconstituted milk in normal milk, a colorimetric method was developed by modifying Evenson's color test for remade milk and cream. This method is based on the fact that the curd of the milk sample, when treated with acetone and Et_2O during washings, dissolves in NaOH soln., giving a transparent soln. which after filtering and heating becomes clear. The depth of yellow color of the sample, which develops when the sample contains reconstituted milk, is then measured and the amt. of reconstituted milk added to normal detd. by means of an electrophotometer or color standards.

Oil manometer for ultra-high vacuum systems.

BIONDI, M. A. *Rev. Sci. Instr., 24,* 989-90 (1953).

A manometer filled with Octoil-S is described and illustrated. It will measure pressures in the range 0-30 mm. Hg and may be read to an accuracy of ±0.01 mm.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

The action of α-amylases.

HOPKINS, R. H., AND BIRD, R. *Biochem. J., 54,* 36, July, 1953.

It was found that when only 10-15% of the linkages in amylose (0.025%) had been split by salivary amylase there were already much maltose and maltotriose present, suggesting that these sugars can be readily split from long chains. This is in agreement with the conclusion of Roberts and Whelan that fission is random except for the terminal linkages. When, however, amylopectin (0.027%) was hydrolyzed, maltose was not observed in the early fission products, whereas maltotriose and higher saccharides appeared in relatively considerable quantities.

An irreversible cholinesterase inhibitor in white clover.

NEATH, D. F., AND PARK, P. O. *Nature, 172,* 206 (1953).

Exts. of clover *(Trifolium repens)* showed anti-cholinesterase activity. This was found not to be due to octamethylpyrophosphoramide, an insecticide active as cholinesterase inhibitor. This clover may produce anti-cholinesterase poisoning in cows eating an excess of this plant.

Additional studies of the properties of taka amylase.

HANRAHAN, V. M., AND CALDWELL, M. L. *J. Am. Chem. Soc., 75,* 4030-4 (1953).

A study was made of the stability and certain other properties of highly purified maltase-free and of cryst. maltase-free taka amylase. Ca ions do not appear to activate taka amylase but do protect it from inactivation under unfavorable conditions. These and other properties of taka amylase are presented and discussed.

The change of molecular weight of egg albumin in aqueous solutions.

SHIBATA, K., AND MURAI, K. *Bull. Chem. Soc. Japan, 25,* 261-3 (1952); *Chem. Abstr., 47,* 5970f (1953).

A study was made of the change of mol. wt. of egg albumin in aq. solns. with special reference to the effect of temp. A 0.3% soln. was prepd. by dissolving egg albumin in distd. H_2O. The relative mol. wt. was measured by detn. of turbidities with a Pulfrich photometer provided with a special device for measuring scattered light. The change in mol. wt. was observed at several time intervals at 30°, 40°, and 50°. The relative mol. wt. increased rapidly within a few hrs. and reached the max. in 4 hrs. One 200 ml. sample at 30° which had reached its max. value, showed no further change when treated with 5 ml. 10 *N* urea. A rise of temp. caused both an increase of the initial velocity and an increase of the max. value of relative mol. wt. The observed increase of mol. wt. was attributed to aggregation.

Unidentified factors capable of reducing stress in iodinated protein-fed rats.

TAPPAN, D. V., BOLDT, R. E., AND ELVEHJEM, C. A. *Proc. Soc. Exptl. Biol. Med., 83,* 135-9 (1953).

A variety of natural products were exam'd. by means of a rat-survival assay for their ability to relieve the stress induced by iodinated casein administration. Mammalian muscle and alfalfa were found to be excellent sources of the protective material(s) being measured, with liver and yeast also contg. significant amts.

A new contraceptive method on biological basis.

BUCHNER, P., HERBRAND, W., AND ROCKL, W. *Deut. med. Wochschr., 78,* 907-11 (1953); *Chem. Abstr., 47,* 11570h (1953).

(Continued on page 18)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

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SELECTED ABSTRACTS

(Continued from page 16)

A polysaccharide compd. which inhibits hyaluronidase and blocks fructolysis in the sperms is effective *in vitro*, in rabbits, and in humans.

MICROBIOLOGY

Bacterial growth in chicken salad.

LEWIS, M. N., WEISER, H. H., AND WINTER, A. R. *J. Am. Dietet. Assoc., 29,* 1094-9 (1953).

Cooling curves are presented which illustrate the time required for a quantity of warm chicken salad to cool to a temp. incompatible with bacterial growth even though the salad was placed in refrigerator. The time required for cooling was related to the quantity of salad and the shape of the container. Bacterial growth curves illustrate the fact that microorganisms grow rapidly when conditions favorable for growth are available.

Hemoglobin in fungi.

KEILIN, D. *Nature, 172,* 390-3 (1953).

An oxygenated yeast suspension had an absorption band at 583 mμ. Contrary to conclusions obtained by previous workers, this band was due to a compd. distinct from cytochrome oxidase. The compd. is present in very few strains of yeast, and so has no important respiratory function. The compd. was shown to be a hemoprotein, which in the ferrous state combines reversibly with oxygen.

NUTRITION

Polymer of glucose as a substitute for saccharin in diabetes.

VASCONCELOS, F. C. *Bol. azucar. (Mex.), 2,* 38-9 (Mar., 1951); *Chem. Abstr., 47,* 11528d (1953).

A polymer of glucose, produced by careful heating of pure glucose *in vacuo*, is reported as a useful product for the dietetic treatment of diabetes.

Studies on obesity. II. Food intake and oxygen consumption.

LYON, J. B., DOWLING, N. T., AND FENTON, P. F. *J. Nutrition, 51,* 65-70 (1953).

Mice of the C_{57} and C_3H strains consumed more cals. when fed a 50% fat diet than when fed a 5% fat ration. Mice of the C_{57} strain consumed more O_2 at the 50% fat level than at the 5% fat level. Thus the extra caloric intake on the high fat diet was oxidized, at least in part. In C_3H strain mice O_2 uptake was not increased in response to the greater caloric intake on the high fat diet. The extra cals. consumed were deposited as carcass fat.

The indispensability of fat in parenteral alimentation in dogs.

MENG, H. C., YOUMANS, J. B., CAIN, W. B., AND GRIMES, D. M. *J. Clin. Nutrition, 1,* 372-83 (1953).

One dog maintained for 4 weeks on complete parenteral alimentation receiving 80 cals. per kg. of body wt. per day, of which 34% came from fat, 16% from protein, and 50% from carbohydrate, remained healthy, lively, and in good spirits throughout. It gained 7.6% of its initial wt. Four dogs were given the same treatment except that fat was omitted and an extra amt. of glucose was added to make up the cals. supplied by fat. Essential fatty acids, including linoleic, linolenic, and arachidonic acids were given as a supplement to 2 dogs. In spite of the supplement of essential fatty acids they lost 9.2% and 4.3% of their initial wt. The other 2 dogs, which received neither fat nor essential fatty acids, lost 9.1% and 6.2% of their initial wt., appeared emaciated and apathetic, and developed lesions characteristic of essential fatty acid deficiency. The belief that the intravenously administered fat emulsion was utilized was confirmed and further strengthened. It is concluded that essential fatty acids can prevent the development of the pathologic changes due to their deficiency but cannot promote body wt. gain and preserve a sense of well-being as well as fat.

Some factors affecting nitrogen balance in the adult rat.

WOMACK, M., MARSHALL, M. W., AND PARKS, A. B. *J. Nutrition, 51,* 117-30 (1953).

The neg. N balances of adult protein-depleted or undepleted rats fed rations contg. low levels of amino acids (14.4 to 14.7 mg. essential amino acid N per day) with sucrose as the carbohydrate were not significantly improved when the total N intake was increased by the addn. of 2 levels of diammonium citrate. The neg. N balances were significantly improved when the essential amino acid N intake was increased to 24.7 and 25.1 mg. per day. N losses of protein-depleted animals were less than those of undepleted animals at the same levels of total and essential amino acid N intake. When corn dextrin was substituted for sucrose in the rations, the animals achieved N equil. at levels of essential amino acid intake which resulted in large neg. balances with the rations contg. sucrose. The beneficial effects of feeding corn dextrin appeared to be due to the change in the carbohydrate and not a gradual lowering of the neg. N balances when animals received rations contg. low levels of amino acids and sucrose for several weeks. Feeding 1% sulfasuxidine with corn dextrin brought about an addnl. improvement in the balances. When potato dextrin was substituted for sucrose there was a small but significant improvement in the N balances at the lower levels of amino acid intake but no difference at the higher levels.

PHARMACOLOGY AND TOXICOLOGY

Safety of sucaryl in large doses.

SCHOENBERGER, J. A., RIX, D. M., SAKAMATO, A., TAYLOR, J. D., AND KARK, R. M. *Am. J. Med. Sci., 225,* 551 (1953); *What's New, 179,* 8-9, Early Winter, 1953.

No evidence of toxicity was discovered after prolonged and excessive consumption of this non-caloric sweetening agent. The results of complete phys. examns. and clinical tests remained within accepted normal limits for all subjects throughout the control and exptl. periods.

Listeria infection in the guinea pig caused by feeding with aureomycin.

ROINE, P., RAITO, A., AND VARTIOVAARA, U. *Nature, 172,* 767 (1953).

Aureomycin was toxic to guinea pigs. By suppressing certain strains of bacteria, aureomycin permitted the active growth of other organisms such as *Listeria* which are harmful to the animal and which caused typical toxicity symptoms.

PHYSIOLOGY AND MEDICINE

Clinical evaluation of dextran as a plasma volume expander.

BOWMAN, H. W. *J. Am. Med. Assoc., 153,* 24-6 (1953).

The results of clinical and lab. studies of dextran are reported as proving the great value of this material as a plasma vol. expander. Studies in progress on the combined use of dextran and modified human globin are mentioned. Polyvinylpyrrolidone or oxypolygelatin can be overlooked as potentially satisfactory plasma expanders, although at present their clinical administration is attended by some difficulty. Finally, plasma vol. expanders are not, and probably never will be, satisfactory substitutes for whole blood. Whole blood is essential for the maintenance of normal human physiol. function.

Alcohol in the body.

GREENBERG, L. A. *Sci. American, 189,* 86-90, December, 1953.

The physiol. effects of EtOH are discussed. Various tales and folklore related to the consumption of EtOH are debunked.

Effect of trypsin on prothrombin.

KLEINFELD, G., AND HABIF, D. V. *Proc. Soc. Exptl. Biol. Med., 84,* 432-7 (1953).

Trypsin converts prothrombin into thrombin. Ca and accessory clotting factors are not essential. Ca does, however, accelerate the rate of thrombin formation but without affecting the thrombin yield. Conversion of prothrombin by trypsin is incomplete. Heparin, in low concns., can inhibit the clotting effect of trypsin by increasing plasma antithrombic activity.

ENGINEERING AND PLANT EQUIPMENT

Electrostatic neutralizers.

BEACH, R. *Product Eng., 26,* 167-71, November, 1953.

The application of electrostatic neutralizers to processing equipment, in order to eliminate static electricity which causes processing difficulties with various products is discussed.

(Continued on page 20)

PREPARED MEAT PRODUCTS can be made notably more appetizing through the use of VIANDAROME* SEASONINGS — stable, uniform flavor additives in measurable, easy-to-incorporate liquid form. VIANDAROME* SEASONINGS can be modified to meet the precise taste preference of the individual manufacturer — an exact seasoning effect always available once its formula has been established and recorded. It's a dependable flavor if it's made by FRITZSCHE . . . *A FIRST NAME IN FLAVORS SINCE 1871.*

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20

SELECTED ABSTRACTS

(Continued from page 18)

FOOD AND FOOD TECHNOLOGY

COCONUT

The extraction of oil from fresh coconut kernels.

MENSIER, P. H. *Oleagineux, 8,* 75-8° (1953); *J. Am. Oil Chemists' Soc., 30,* 263 (1953).

The methods that were patented for the extn. of oil from fresh coconut kernels rather than from copra are discussed. It is concluded that such methods eventually will replace copra operations.

FATS AND OILS

The plasticity of fats.

GREETHEAD, G. F. *Food Technol. Australia, 5,* 195° (1953).

The factors influencing plasticity, methods of evaluation, and some of the more important applications of plastic fats in the manuf. of table spreads.

FEEDINGSTUFFS

Particle sizes for additives to animal foods.

BLOOM, C., AND LIVESEY, E. F. *Mfg. Chemist, 24,* 371-5 (1953).

The growing practice of adding supplements such as antibiotics, vitamins and minerals to animal foods, sometimes in quantities as small as 0.002 oz./ton, has created considerable difficulties in ensuring uniform distribution of the active substance throughout the mix. A mathematical model to calc. the particle size necessary to ensure even distribution at different levels of supplementation was constructed and this model was tested by radioactive tracer checks of different mixes. The supplements considered were procaine penicillin, riboflavin and vitamin B_{12}.

INSECT DETECTION

Aural detection of grain infested internally with insects.

ADAMS, R. E., WOLFE, J. E., MILNER, M., AND SHELLENBERGER, J. A. *Science, 118,* 163-4 (1953).

A sound detection device was constructed which made possible the detection of internal or hidden insect infestation in grains by electronic means. The equipment consisted of a low noise level audio amplifier, a suitable microphone and a loudspeaker. Records of wave patterns were made for analysis. With this equipment an experienced observer can est. the approx. stage of development of the insect. A suitable sound detection device for performing such tests in mills and grain elevators is now under construction.

ODORS AND ODOR REMOVAL

An assessment of chlorophyll as a deodorant.

BROCKLEHURST, J. C. *Brit. Med. J. I,* 541-4 (1953); *Chem. Abstr., 47,* 11656d (1953).

Various com. H_2O-sol. chlorophyllin prepns. at various concns., including 12.5% and 1 g. in 10 ml., failed to take up MeSH more rapidly than did H_2O under the same conditions, failed to remove the odor of MeSH, Me_2O, or sirup of garlic exposed to them at least 12 hrs., and failed to remove the odor of perfume after 5 months or of onion after 24 hrs. (duration of expts.). Ingestion of 800 mg. of chlorophyllin daily for a week did not remove the odor of urine, feces, or axillary perspiration.

Odor research. 2.

MONCRIEFF, R. W. *Mfg. Chemist, 24,* 292-4 (1953).

A report on papers presented at the Conference on Basic Odor Research Correlation. Titles include: odor identification; observations on olfactory intensity; surface phenomena related to odor measurements.

ORGANIC CHEMISTRY

A new hydroxy acid in the peel of apple fruits.

HULME, A. C. *Nature, 172,* 346 (1953).

The acid was isolated from silica gel, m.p. 94-96° C., mol. wt. 146, mol. formula corresponding to $C_5H_8O_5$. The acid was provisionally identified as β-OH-glutaric acid or citramalic acid.

Free xylose in fruits.

HAY, J. G., AND PRIDHAM, J. B. *Nature, 172,* 207 (1953).

(Continued on page 24)

Notes from the makers of
Myvax Vitamin A

Vitamin A palmitate in the book

Every once in a while somebody comes up with something that doesn't raise much dust at the moment but turns out to be of considerable importance in the long run.

Vitamin A palmitate, for example.

We ran across it back in 1938 when we were distilling some Norwegian cod-liver oil in a molecular still—a speciality of the house. We found that from the collection of fatty acid esters which constituted the vitamin A in this oil, we were able to pull out three percent as the palmitate. *The Journal of Biological Chemistry* obligingly published the 2½-page paper we wrote about our discovery.

That wasn't exactly a bombshell at the time; but now almost everyone who puts vitamin A in his product uses some palmitate.

We don't make much vitamin A by molecular distillation any more. Most of it is synthesized by a method we worked out some time back. The process is efficient, the product tastes good, the potency is high. We can ship as much as you want from stock, as Myvax Vitamin A Palmitate, Myvax Vitamin A Acetate, or Myvapack Vitamin A in batch-sized cans. If you run into any trouble putting vitamin A into your product or want to know something about how it will act when eaten, we'll be glad to help there, too.

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pH in food processing

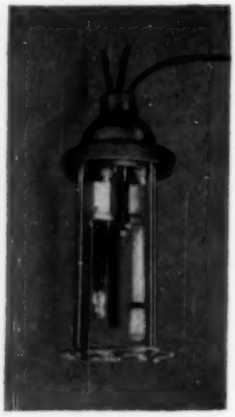
Making better food products at lower cost . . .

ACIDITY and alkalinity are more than a matter of taste in food products. They are chemical characteristics that influence many food qualities and processing operations. Through the application of modern instrumentation, these characteristics can be readily measured and often controlled automatically.

What is pH?

Chemists have devised the pH scale as a means of expressing the acidity or alkalinity of a solution. The scale extends, for all practical purposes, from 0 to 14. The numbers are a way to measure the concentration of hydrogen ions in a solution. Pure water has a pH of 7. Below 7, solutions are acid; the more acid, the lower the pH number. Conversely, alkaline solutions have a pH value above 7, and keep getting higher as they become more strongly alkaline. The scale is logarithmic; a change of 1 pH means a ten-fold change in the hydrogen ion concentration.

Flow type electrode assembly.



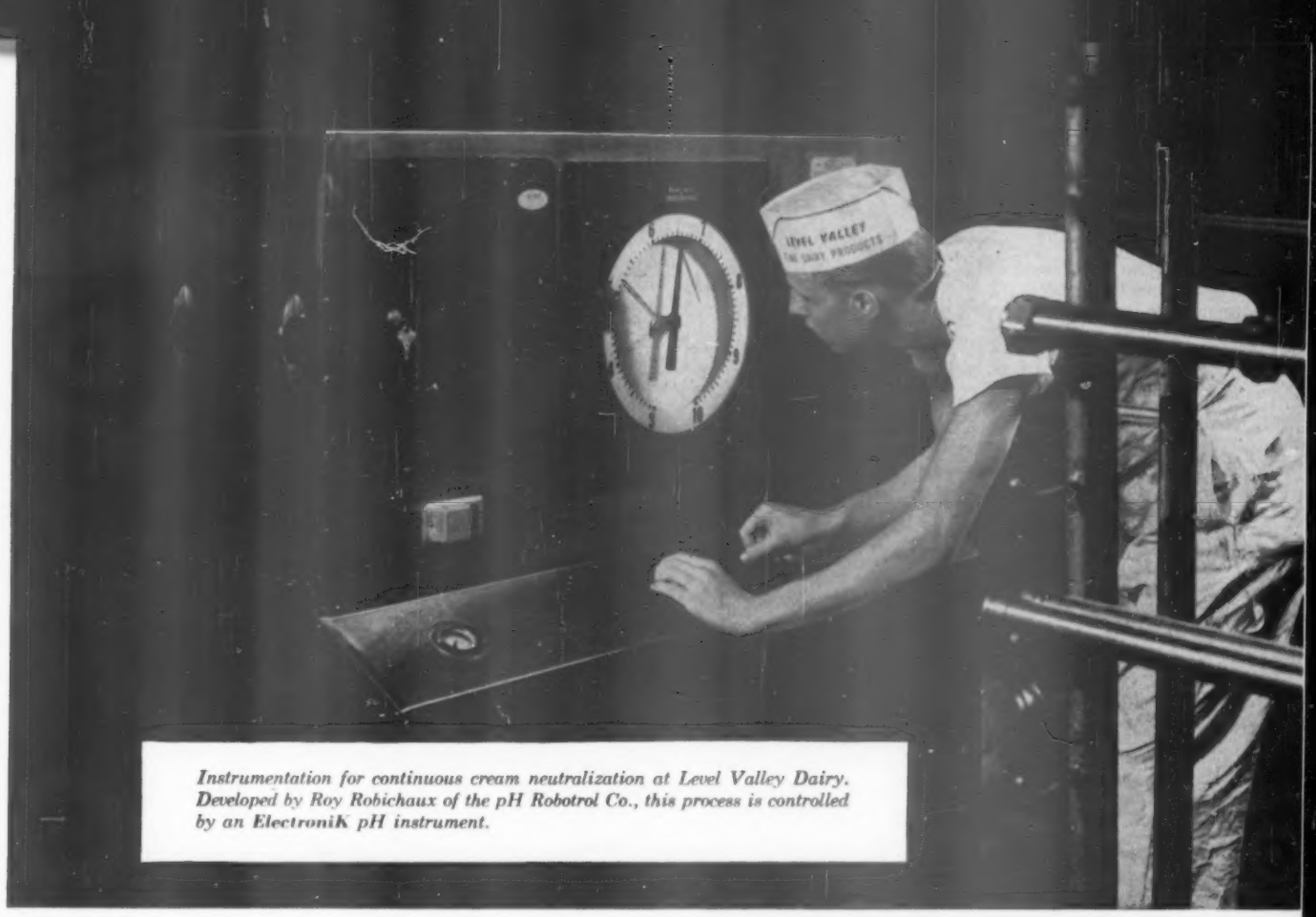
Immersion type electrode assembly.

How is it measured?

Formerly requiring elaborate laboratory equipment, pH measurements are made today in many industries by means of the glass electrode system. This consists of a pair of elements, one of which has a special glass bulb at its tip, continuously immersed in the solution to be tested. The electrical millivoltage which this system develops is measured by an electrometer and is recorded directly in pH units by an *ElectroniK* potentiometer.

How about control?

The *ElectroniK* pH instrument can often regulate the flow of a corrective reagent to hold pH at a set value . . . thus eliminating the uncertainties of manual operation. For instance, if a product is slightly acid and it is desirable to make it neutral, the instrument actuates a valve to adjust the addition of an alkaline solution. pH control requires engineering by a Honeywell specialist, who takes into consideration such factors as reaction time, buffering action and process lags. When properly designed, pH control can make valuable contributions to product quality, uniformity and economy in many food processes.



Instrumentation for continuous cream neutralization at Level Valley Dairy. Developed by Roy Robichaux of the pH Robotrol Co., this process is controlled by an ElectroniK pH instrument.

. . through automatic pH control

THE WAY that modern instrumentation can help convert a hit-or-miss batch process into a closely regulated, continuous operation is well exemplified by the continuous cream neutralization system at the Level Valley Dairy, West Bend, Wis. Under the control of an *ElectroniK* pH instrument, this process automatically adjusts the acidity of cream going through a continuous pasteurizer. Here, as in other dairies where the *pH Robotrol* process is operating, several outstanding benefits are being realized.

Improved flavor—no oxidized taste, no "tallowiness" from overneutralization.

Longer storage life—butter stays fresh longer; doesn't get "fishy" due to over-acidity.

Faster production—continuous, fully automatic process eliminates delays of batch operation; ends need for accumulating cream receipts before processing. Many plants can double daily production!

Honeywell instrumentation offers food processors unlimited opportunity to improve efficiency and product quality. At your service is a thorough line of measuring and controlling instruments encompassing practically every food process—plus an extensive background of engineering experience in the control problems of the industry. Your nearby Honeywell sales engineer will be glad to discuss your own plant's applications . . . and he's as near as your phone.

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SELECTED ABSTRACTS

(Continued from page 20)

An investigation of the carbohydrates present in the Victoria plum has revealed the presence of small amts. of free xylose in the juice of ripe and immature fruits.

PACKAGING RESEARCH

Antioxidants for food papers.

BENTZ, R. W. *Modern Packaging, 27,* 141-3, September, 1953.

Rancidity acceleration due to wrapping papers can be caused by metallic contamination, increased surface area and admission of light. Butylated hydroxyanisole shows unusual effectiveness as an inhibitor of rancidity in fats and fatty foods. The methods of incorporating it in packaging materials, and users of this material, are discussed briefly.

What's ahead for aluminum cans.

Canner, 117, 23, November 2, 1953.

Advantages include light wt., resistance to rust, good long-lasting appearance, easy opening and the future assurance of abundant supplies at reasonable prices.

PHYSICAL RESEARCH

Roll call for particle sizes.

Chem. Eng., 60, 250, September, 1953.

Discussion of a new app. which rapidly and accurately dets. particle size distribution for powd. material in the range of 1 to 100 μ with air sedimentation.

RADIOCHEMICAL TECHNOLOGY

Production of radioisotopes.

RUPP, A. F., AND BINFORD, F. T. *J. Appl. Phys., 24,* 1069-81 (1953).

An excellent summary of methods of irradiation now available, choosing targets (criteria), production rates and related matters. Some practical aspects of radioisotope production in the reactor are discussed. A table of methods of radioisotope prepns. and methods of shipping various radioactive materials are also given.

The yields of free H and OH in the irradiation of water.

ALLEN, A. O. B.N.L. 1498, 25 p. (1953); *Nuclear Sci. Abstr., 7,* 577, No. 4754 (1953).

Exptl. investigations of the quant. radiation chemistry of H_2O are reviewed. Contradictions in evidence regarding the existence of an excess of H atoms and H_2O_2 over OH and H_2 are discussed. It is concluded that in spite of the large amt. of exptl. work and the relative simplicity of the system there is no firm exptl. grounding for any theory of the radiation chemistry of H_2O.

WATER FLUORIDATION

A rational approach to fluoridation.

MCKEE, J. E. *J. Am. Water Works Assoc., 45,* 376-86 (1953); *Chem. Abstr., 47,* 6583a (1953).

Ten fundamental facts on fluoridation are listed, and the advantages of using milk as a carrier are cited. 22 references.

PATENTS

Eggs having artificial shells.

ADAMS, D. 2,660,530, November 24, 1953.

An individual egg having an artificial shell of flexible sheet material enclosing its yolk and albumen and shrunk into generally spherical closely confining relation to the yolk and albumen with the yolk intact and substantially uniformly surrounded by albumen.

Method of making available the bitter substances from hops.

NILSSON, T. R., AND SANDBERGEN, K. E. 2,652,333, September 15, 1953.

In a method of converting the bitter substances non-sol. in water, remaining in hops residue after obtaining from the same the water-sol. bitter substances in a manner shown *per se,* the step of subjecting the bitter substances of the residue to a partial oxidation so as to convert its content of β bitter acid into water-sol. soft resins.

New Registration Procedure
for
14th Annual Meeting of the Institute
of Food Technologists
Los Angeles
June 27 - July 1, 1954

In an effort to reduce the awkwardness of the usual registration procedure at conventions, the Southern California Section, host for the 14th Annual Meeting, will introduce as mentioned in the March issue a streamlined system for registration. National members, students and exhibitors will have an opportunity to preregister and obtain reservations for tickets to all scheduled functions. The Preregistration System, developed with the cooperation of the Remington Rand Corporation, will be facilitated through the use of punchcards. With the aid of automatic sorting and printing machines it will be possible to print individual tickets, each enscribed with the registrant's name, for all events listed and requested on the PREREGISTRATION APPLICATION FORM. The new system will not only reduce the total time, effort and expense of preparing meeting rosters, but will also increase the overall efficiency and effectiveness of registration. In the interest of fairness to registered members, for the first time technical sessions and social functions will be monitored by uniformed, professional guards. No one will be permitted to obtain tickets or attend scheduled functions without a badge. Therefore, it was mandatory that a preregistration system be innovated in order to prevent peak loads and disorder during registration preceding the Sunday evening Social Hour and the Monday morning sessions. It is hoped that a major proportion of the anticipated registration will cooperate by *Preregistering* well in advance of the meeting and prevent awkwardness and the loss of time during Registration.

In addition to the convenience afforded Preregistrants and their wives, they will have the advantages of priority on tickets for functions of limited attendance, personally enscribed tickets and receipts and automatic inclusion in the first edition of the Meeting Roster. To take advantage of PREREGISTRATION, all *applications* and *payment* must be received prior to June 15, 1954. Separate registration applications will be necessary for wives or husbands of members, although no

(Continued on page 30 following technical papers)

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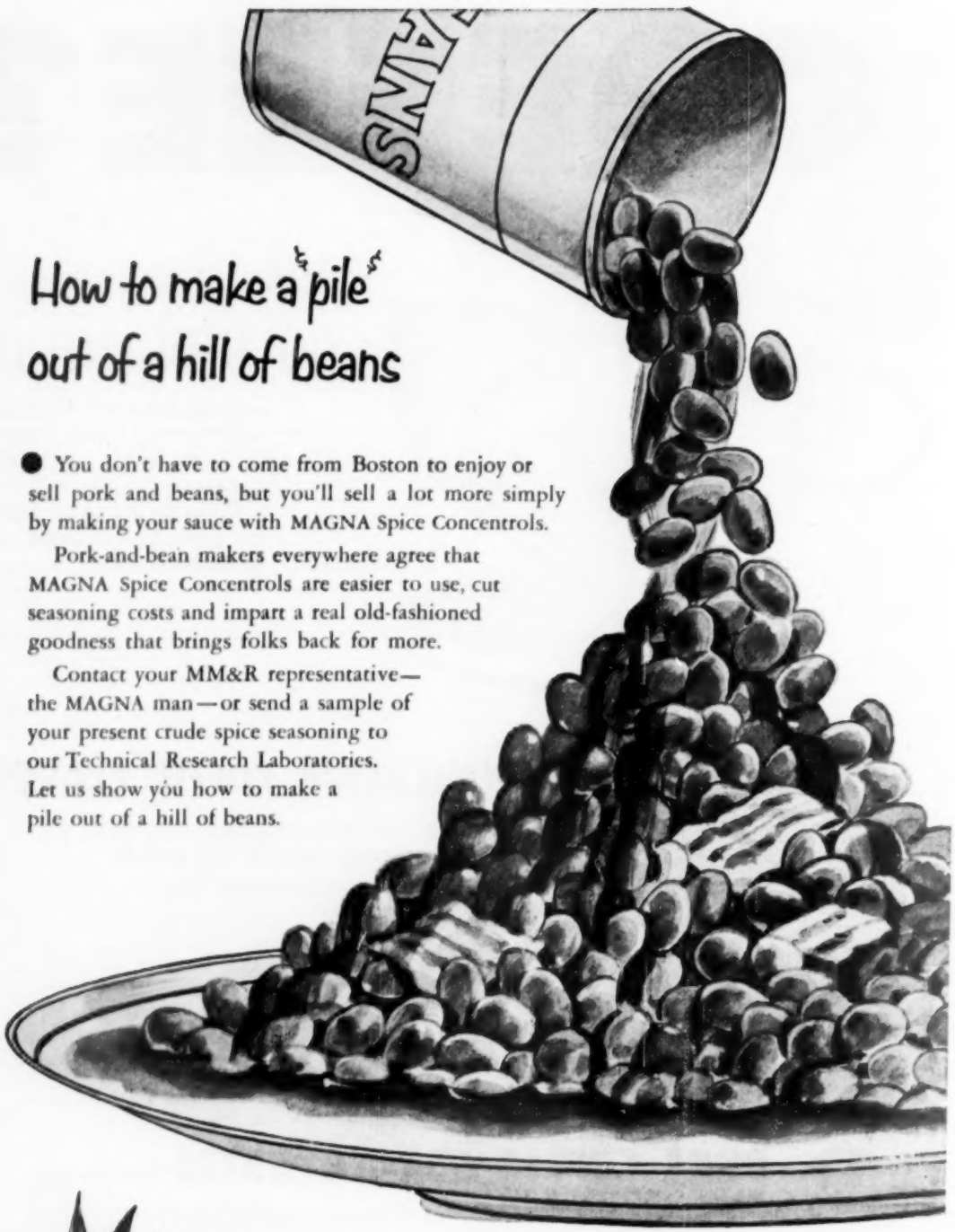

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Point Four Activities in Fishery Technology in Peru

NORMAN D. JARVIS

Office of Foreign Activities, U. S. Fish and Wildlife Service, Department of the Interior, Washington, D. C.

(Manuscript received June 16, 1953)

The work in fishery technology herein described is an example of the breadth of the field the food technologist may be called on to cover in the so-called "under-developed" countries, and gives as well an idea of the Point 4 program in fisheries as it works in Peru.

In comparison with the northern hemisphere, the southern hemisphere is unimportant in the distribution of world fishery production. According to the F. A. O. *Yearbook of Fishery Statistics for 1948-49 (1)*, South America accounted for only 2% of the world total. Until recently, authorities on fisheries thought that because of natural conditions, such as the extremely narrow width of the continental shelf, the scanty supply of plankton and other fish food, and water temperatures, the resources of this area were limited to a subsistence basis. Today, however, it is apparent that certain parts of the southern hemisphere, such as the Pacific coast of South America, show much greater promise of increased production than was formerly thought possible.

BACKGROUND FACTORS IN THE DEVELOPMENT OF THE PERUVIAN FISHERY INDUSTRY

Aquatic resources. The upwelling of the Humboldt current along the coasts of Peru and Chile brings a mass of cool water close along the shore of the greater part of the Pacific coast of the continent. This water, with a higher nutrient content than is found in warm, tropical waters, makes conditions favorable for the development of plankton and other semi-microscopic fish food. These foods support large populations of small fish, especially the anchovy *(Engraulis ringens)*, which in turn forms the main food supply for large food fishes. The warm waters of the tropical current meet the Humboldt current off the northern coast of Peru. The invasion of the cool coastal current by warm water tongues of the tropical current makes the coast of Peru a mixing bowl, bringing in important warm water pelagic forms, such as the tuna and swordfish, to feed on the unusually rich food supply of the Humboldt current *(2)*. The bonito, occurring generally in the area in which the coastal current flows, generally follows the anchovy. In the period from October to March (summer in the southern hemisphere) the bonito are found close inshore, since the warm oceanic waters force them into the belt of cold water along the coast, and the anchovy are thus concentrated in the area. The tuna, yellowfin, and skipjack then appear in abundance in the warm water tongues north and south *(3)*.

Economic considerations. During the past ten years a great development has taken place in the fishery industry of Peru. Fishery products, principally canned bonito, frozen tuna and swordfish, and fish meal, have become one of the most important exports and sources of dollar exchange. According to Peruvian reports, only the exports of minerals, cotton and sugar are more important *(5)*. The Ministry of Agriculture in its most recent reports estimates the total catch at 133,761,500 pounds, a most encouraging yield since it is more than five times the catch of 1940.

Although the Republic of Peru is glad to see the commercial development of her fisheries, this important natural resource is not valued primarily for its possible contributions to the export market. In fact, when the first Fishery Mission was assigned to Peru in 1941 (at the request of the Peruvian Government, which paid all expenses) the assignment was to determine the fishery resources of Peru, and to study methods for their development, with special attention to domestic use. The supply of meat in Peru was, and is today, extremely short. The purchasing power of the population in general is low, so that methods and products developed cannot be high priced. It was felt that with the possibility of making up the deficiency in meat by a greater local supply of fishery products the Peruvians would have a better food supply and would be availing themselves of an unutilized resource. Since the Peruvian government had no special organization for the development and control of fisheries, recommendations were also requested on this point *(4)*.

The Fish and Wildlife Bureau, Republic of Peru. In accordance with the recommendations of the Fishery Mission and following consultations between the Peruvian government and the U. S. Fish and Wildlife Service, a Fish and Wildlife Bureau was established in the Ministry of Agriculture, Republic of Peru. The primary function of this bureau is to increase the production of fish for domestic use, so that a population badly in need of protein foods can have a sufficient supply of good quality fishery products at a reasonable price. The task is a challenging one. The almost total lack of transportation, fishing boats and gear, handling and storage facilities, especially refrigeration, besides adverse temperature conditions, particularly in the Amazon region, make the problem of increasing production a complicated one. Besides adding to the food supply, the Peruvian Fish and Wildlife Bureau is also commissioned to set up a scientific system of fishery management, to conserve the fishery resources of both salt and fresh waters.

An impetus to rapid development. The Americas were involved in the Second World War even before the report of the Fishery Mission was completed, and the war gave the impulse to the commercial development of the Peruvian fisheries *(5)*. The supply of canned fish in the United States was inadequate. The bonito landed in Peru were found to make a good quality canned product. There was also considerable demand for salt fish. In the last period of the war, and in the first years of the post-war period, the United Nations Relief and Rehabilitation Administration (U.N.R.R.A.) bought considerable quantities of salted bonito, brine-packed, for famine relief purposes in Europe.

Salt bonito required little equipment for packing, the method was simple and the margin of profit large. A number of canners acquired their capital and first experience in the industry as packers of salt bonito. When U.N.R.R.A. ceased purchase in 1947 of salt bonito for relief supplies, this product was no longer packed. But during and after the war, Peruvian canned bonito was not subject to price ceilings. A number of food-sales companies in the United States became interested in Peru as a possible source of supply and encouraged a rapid development of the fish canning industry. Canning machinery and supply firms in California supplied the necessary equipment and technical instruction that made initial development possible. At the end of the war, the United States was the entire export market for sale of canned bonito and tuna. Since the war, an effort has been made to build up other export markets. Shipments are now made to Belgium, Great Britain, Italy, Switzerland and to other South American countries, especially Argentina and Venezuela *(5)*.

DEVELOPMENT OF A TECHNOLOGICAL LABORATORY AND A TRAINING PROGRAM

Unfortunately, the training by United States commercial interests mentioned in the preceding paragraph was of necessity brief and pragmatic. There was a tendency in the Peruvian industry to insist that after this short training, their canners were completely trained. At that time, too, there was no regulation of the fishery-products industry, especially as to plant sanitation and product control. The success of the Institute of

Inter-American Affairs in its cooperative program of improving the food supply in other fields led the Peruvian Government to request through the Institute of Inter-American Affairs that a scientific advisor be detailed to the Fish and Wildlife Bureau, Ministry of Agriculture, Republic of Peru, to help this organization institute a sound program for the development and utilization of its fisheries. Later, the Peruvian Government requested the services of a technologist to equip and put into operation a technological laboratory and to act as general advisor.

The program, administration, and control has always remained with the Peruvian agency. The aim of the Institute of Inter-American Affairs, under the Point 4 program, is not to take over and show the people of the so-called "under-developed" countries our industrial "know-how." The aim is to suggest and educate. Projects are initiated by the foreign governments. Their people are given advice and training by our government when the proposed project is feasible. As soon as possible on each project, the advisor from the United States moves on.

It should be reiterated that the establishment of a technological laboratory was a Peruvian decision. It was realized that the fishery products industry and the import of fishery products must be regulated. The Peruvian Bureau of Fish and Wildlife was called on for help in problems involving the development of better methods for handling fresh, iced, refrigerated and cured fish, smoked, dried, pickled and salted fish, by-products—in fact, anything touching on fishery products in any way. In the United States this diversity of problems would be handled by a variety of agencies, permitting greater research and technological emphasis on each problem area. With such a variety of problems, a technological laboratory could very easily end in accomplishing nothing by attempting to do everything. But the problems were there—awaiting attempts to solve them.

It will be instructive to turn for a moment to the facilities themselves. The laboratory, located at the fishermen's wharf, in Callao, the Port of Lima, was planned and equipped to handle a limited program. The building consists of an office and reception hall, a library, store rooms and a large main laboratory room, serving both as a cutting or examination room and the locus for experimental work in preparing and demonstrating packs of fresh refrigerated, salted, dried, smoked and canned fish. On one side of the main laboratory there is a small chemical laboratory containing standard analytical equipment; on the other side there is a small bacteriological laboratory. Since it never rains in this area, a smokehouse was built outside. A pilot plant temperature and humidity controlled drier is planned, but not yet built.

The problem of personnel. In Latin America it is very difficult to obtain good scientific personnel. The scale of pay of professional personnel in these countries is the same as that for routine clerical help. Inflation has made greater inroads on the scale of living there than in the United States; hence it is usually necessary for a chemist or food technologist to hold one or more jobs on the side.

On our arrival, the technological division was staffed by two men, graduates of the University of San Marcos, in Lima. Later, a chief technologist was appointed, also a graduate of the University of San Marcos, who had, in addition, a year of training in fishery technology in the United Sttates. Two additional chemists and a bacteriologist were appointed.

Up to this time professional positions had been filled by political appointment. The technical advisor from the United States was directed to hold competitive examinations which were the first, so far as can be determined, ever held in Peru. The examination was designed to test the knowledge of chemical engineering as widely as possible. Exact answers were required to be given for most questions.

Out of a large number of applicants, two men and one woman passed the examination. They entered on a period of training while the laboratory was being built and equipped. They are still at the technological laboratory, and they deserve great credit for their accomplishments. They are enthusiastic about their work, eager to obtain as much training as possible in fishery and food technology, and are honest and reliable under very difficult conditions.

NATURE AND SCOPE OF THE PROGRAM

Training in plant survey methods. One of the first tasks undertaken by the laboratory was a field survey of the canning industry, to obtain data to serve as a basis for recommendations for control and production methods, equipment, and for training in cannery sanitation and production control. The students were taught how to conduct a plant survey by actual demonstration. After a short time each student was required to write down the findings of these surveys independently; their reports were then analyzed and discussed. This project proved to be of much benefit in orienting the students in a diversity of later tasks.

Training in inspection procedures. When the laboratory was finally completed and equipped, the first activity of a technological type was instruction in the examination and analysis of fishery products. The laboratory is required by law to examine all imported products of aquatic origin, and to certify that they are fit for consumption. The range is extremely wide—air-dried, salted, dried and salted, smoked, pickled and canned products. Peru has a cosmopolitan population and the variety of products imported is probably wider than enters almost any single port in the United States. It was difficult to impress on the students that sampling and examination were not mere routine procedures. In time, however, they became good at organoleptic examination. The students were also given limited training in chemical and bacteriological examinations, principally where additional proof of spoilage was needed. The Peruvian technologists now have the respect and confidence of the importers in Peru.

The Republic of Peru has no "pure food law" and up to this time there have been no provisions for cannery inspection and control. The laboratory came into the picture when it was requested by the Peruvian Government that a pure food law be drafted, adapted to local conditions, and especially designed to permit regulation of Peruvian canneries and fish-packing plants. The law and regulations, which follow more or less closely the Food, Drug and Cosmetic Act of the United States, have just been approved. Detailed instructions were also worked out for the inspection of fish canneries, including sanitation and general cannery inspection. Inspection procedure has been modeled on that of the State of California. A manual of instruction was prepared for the inspectors. The result of this work should be to improve the quality and standardize the fishery products of Peru.

Training in the elements of grading. During the plant survey and training in the examination of imported products, intensive instruction was also given in the examination of domestic canned products, especially bonito and sardines. Emphasis was laid on determination of quality of the fish when caught and when canned; workmanship in canning, and physical examination of the container. Most important was the determination of spoilage or incipient spoilage, and the detection of faults in canning procedure. Today the technologists are able to recommend improvements in canning procedure to the local canners, and grade the

products examined quite accurately, so that products of inferior quality are not certified for export.

There were also requests that technologists be trained to determine the differences between fresh and stale fish and instruction in the proper handling of fish—in the boats, during transportation, and at the markets.

Experimental work. Since canning is to be recommended only in countries with a high purchasing power, the first experimental work at the laboratory in Callao was a study of fish-curing methods. The Peruvians regularly eat dried, salted fish when it is available. The product prepared heretofore was of low quality and did not keep long enough to reach the markets of the interior.

The experimental work on salting demonstrated that a satisfactory dried, salted product could be prepared even in a warm climate by using a better grade of salt in sufficient quantity, reducing the moisture content of the fish and overcoming the atmospheric humidity during the curing period.

A study was also made of methods of smoking. In the coastal markets the people of Peru are accustomed to imported "blind robins" (hard-smoked, hard-salted herring). In the interior country of the Amazon basin the people have learned to smoke fresh water fish, but the method is very crude and the product does not keep well. Methods were developed for smoking low-priced varieties such as flying fish and other material such as bonito roe now wasted or used only in fish meal. The products, which have been very popular among the Peruvians, have good keeping qualities. The best results, both for color and flavor, were secured with mahogany chips and sawdust, algaroba wood, and wood of dead orange trees.

Other activities of the laboratory. The Peruvian technologists were given experience in all steps of the process of smoking. They were trained so that they could become instructors and demonstrators to other Peruvians. Publications on fish preservation were prepared in simple, non-technical language.

It was requested that instruction be given in preparing material for increasing the use of all types of fishery products for food. In Peru the heads and other trimmings such as backbones, are not usually considered waste. They are valued in making soup. Fillets are saleable only among foreigners, such as North Americans and English. A booklet was prepared, with recipes most likely to appeal to Peruvians, using low-cost species of fish and cooking methods and with other information to encourage the use of fish in Peru.

A course in fishery technology was given, especially adapted to conditions in South America, covering the same ground as those given to scholarship students sent from South America to the United States. The lectures were written in English and then translated into Spanish.

CONCLUSION

The Peruvian technological laboratory has made good progress. The technologists have learned to work independently. They have found means for increasing the production of fresh, frozen, cured and canned products in the domestic market and are showing the fishing industry of Peru how to produce products of better quality. Best of all, they are taking an active interest and pride in their work, and in the honor and reputation of their organization. In this brief account of the inception and growth of a technology it should be apparent that within the span of a few years the main lines of a Peruvian fishery technology were established—an encouraging sign for the future.

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Preliminary Experiments in the Use of Chlorella as Human Food

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The use of unicellular algae such as chlorella as a food supplement is discussed, since the production of these algae by industrial methods may be feasible. Algal powder increases the protein and vitamin content of foods to which it is added and palatable bread, noodles, ice cream, soups, etc., thus fortified are described. Acceptable "soy sauce" can be prepared by processing chlorella.

Among human sensations, perhaps the most complicated and intangible are those of taste. Closely associated with other physiological functions as well as with multifarious psychological factors, the gustatory sense is affected not simply by the palatability of substances, but also by traditional prepossessions of individuals as well as by capricious fads and propaganda. It is, indeed, a most difficult undertaking to introduce a new item of human food, unless its taste and appearance are quite similar to those of other popular foods or unless it has some special nutritive or medicinal effect without

[a] Some of the experiments reported were carried out at the Carnegie Institution of Washington's Department of Plant Biology, Stanford, California. Members of the Department staff assisted in testing the products.

any disagreeable taste or appearance. Theoretically, we may, by proper processing, extract palatable substances from almost all natural organic materials around us, even those that have an abominable taste in the raw state. Obviously, however, it is the cost of processing that determines the usability of such raw organic materials as sources of human food.

For unicellular algae to be readily acceptable as human food, they must, either in the raw state or after being processed in the simplest possible way, either have a taste, odor, and appearance that are similar to, or reminiscent of, those of some pre-existing popular food; or have no peculiar taste, odor, or appearance, so that they can be mixed with other foods without being noticed. We have attempted to test the usability of chlorella as food by adding it in the raw dried state to some common foods, and also by processing it by certain simple methods.

We will discuss the origin and nature of chlorella powder and describe some foods enriched with it. The nutritional value of its addition to bread, noodles, and ice cream as well as the occurrence of vitamins, amino acids, and carbohydrates in chlorella will be listed. In addition to the direct addition of chlorella powder to foods, a processing method for the preparation of "soy sauce" from chlorella will be described.

MATERIAL USED

In most of the experiments we used dried and powdered cells of *Chlorella ellipsoidea* which had been grown in the "urea-EH" medium described by Tamiya *et al. (2)*. The algal cells, separated from the culture medium, were washed once or twice with water by centrifuging, and the thick paste of cells obtained was dried at room temperature with infrared lamps and an electric fan. The dried mass of cells was then crushed and ground to fine powder in a mortar.

The powder is dark green and a little hygroscopic. Kept in an ordinary atmosphere, it absorbs water to about 8.5 to 10% of the total weight. Its appearance is similar to, although its color is a little darker than, that of the powdered green tea which is commonly used in the traditional tea ceremony in Japan. Its taste, though not exactly the same, is very similar to that of powdered green tea and powdered dry "aonori," a seaweed *(Enteromorpha compressa)* which is commonly used as seasoning in Japanese cookery.[b] Cells dried at temperatures lower than 15° C. have a milder taste and odor than those dried at higher temperatures.

ADDITION OF CHLORELLA POWDER TO FOODS

Tests were made to determine to what extent chlorella powder can be added to various common foods without causing queer or disagreeable taste sensations. In each case, tasting was done by several adults, both American and Japanese.

(a) *Powdered green tea* ("hiki-cha").[c] To powdered green tea of ordinary quality, chlorella powder can be added, without causing a significant change in taste, up to as much as 20% of the total weight. To mix well with tea powder, algal cells must be ground as finely as possible.

(b) *Soups.*

Western style. One or 2 teaspoons of chlorella powder added to bean, mushroom, or beef soup or to consomme was excellent, but in chicken soup the taste was not so pleasant. The green color of algae is less apparent in cream soups than in clear ones.

Japanese style. A Japanese-style soup was prepared using not only chlorella powder and a dried seaweed, "kombu" *(Laminaria japonica)*, but also a substitute "soy sauce" made of chlorella cells. (For this sauce, see a later section of this paper.) A piece of dried "kombu" 3½ inches square is boiled with 4 cups of water for 3 minutes, after which ½ cup of "katsuobushi" flakes (flakes of dried meat of bonito), 2 tablespoons of "sake" (Japanese rice wine), and ½ teaspoon of sodium glutamate are added successively at 3-minute intervals. To 1 cup of the supernatant of the above solution are added 1 or 2 teaspoons of chlorella powder, ¼ teaspoon of chlorella "soy sauce," and ¼ teaspoon of salt.

(c) *Noodles.*

Western style. Tasty green noodles were prepared by kneading 4 teaspoons (9.4 g.) of chlorella powder with 1 cup (142 g.) of flour, ¼ teaspoon (3.3 g.) of salt and ¼ cup (60 ml.) of water.

"Soba," a buckwheat noodle of Japanese style. "Soba" is one of the most popular foods in Japan and is made with 30 to 50% buckwheat flour and 70 to 50% wheat flour. By adding 2 to 5% chlorella powder to this mixture of flours we obtained a green noodle almost identical, both in appearance and in taste, with the so-called "cha-soba," a choice type of "soba" containing powdered green tea as an ingredient.

(d) *Bread and rolls.* Green-colored French bread having an interesting and agreeable taste was prepared by adding 8 tablespoons (56 g.) of chlorella powder to 6 cups (852 g.) of white flour, the mixture being baked in the usual way after adding 1 tablespoon (14 g.) of sugar, 2 teaspoons (27 g.) of salt, and one yeast cake (5 g. dry weight).

Richer in taste were rolls prepared with the following materials: 8 tablespoons (56 g.) of chlorella powder, 4 cups (568 g.) of flour, ½ cup (110 g.) of butter, 1 cup (237 ml.) of milk, 7 tablespoons (99 g.) of sugar, 2 eggs, 1 teaspoon (13 g.) of salt, and one yeast cake. Addition of nuts increased the attractiveness of the rolls in taste, texture, and appearance. Fancy-looking rolls with variegated colors were prepared by layering ordinary dough alternately with that containing chlorella.

(e) *Cookies.* Different kinds of green-colored cookies were prepared by mixing chlorella powder with flour. Appropriate proportions of ingredients for a simple recipe are: 2 teaspoons (4.7 g.) of chlorella powder, 2 cups (226 g.) of cake flour, ½ cup (114 g.) of sugar, ¼ pound of butter, and 1 small egg.

(f) *Ice cream.* Surprisingly large amounts of chlorella powder can be added to ice creams. Not only is the dark green color of the algae diluted to a pleasant light green, but also the characteristic taste of the algae effectively accentuates the basic taste of ice cream. To one cup of vanilla ice cream, more than 5 teaspoons of chlorella powder may be added. The proportion of ingredients in such an ice cream is, for example, as follows: 10 tablespoons (71 g.) of chlorella powder, 4 cups (1000 g.) of evaporated milk, 2 cups (473 ml.) of milk, 1 tablespoon (89 g.) of flour, 1 cup (227 g.) of sugar, 2 eggs (98 g.), and 2 tablespoons (30 ml.) of vanilla extract.

ESTIMATED QUANTITIES OF NUTRIENT SUBSTANCES IN CHLORELLA-CONTAINING FOODS

To what extent does the addition of chlorella powder increase the nutritional values of the foods described above? Table 1 shows the estimated content of various substances in French bread (containing 8 tablespoons of algal powder per 6 cups of flour), noodles (Western style, containing 4 teaspoons of algal powder per 1 cup of flour), and ice cream (containing 4½ teaspoons of algal powder per 1 cup of ice cream).

[b] Besides this seaweed, there are a number of algae, from both fresh and sea water, which are popular in Japanese cookery. Some examples are: suizenji-nori *(Physlodorma sacum)*, kawanori *(Prasiola japonica)*, hitoegusa *(Monostroma nitidum)*, makombu *(Laminaria japonica)*, wakame *(Undaria pinnatifida)*, hijiki *(Hijikia fusiformis)*, arame *(Eisenia bicyclis)*, mozuku *(Cladosiphon decipiens)*.

[c] This kind of tea is served not as a water extract, as are other kinds of tea, but as a suspension of tea powder in hot water, prepared by beating the mixture with a small bamboo whisk immediately before serving. The somewhat bittersweet taste of raw young tea leaves is much enjoyed by Japanese people, but does not appeal to most Western people.

TABLE 1

Estimated quantities of principal nutrient substances in some chlorella-containing foods

(The composition of chlorella cells was taken, following Ketchum *et al.* (1), as being 42% protein, 22% fat, 24% carbohydrate, and 12% ash, in dry weight)

Composition (per 100 g. dry weight)	Protein (g.)	Fat (g.)	Carbohydrate (g.)	Ash (g.)	Vitamin A (I. U.)	Vitamin B_1 (mg.)	Vitamin B_2 (mg.)	Vitamin C (mg.)
French bread:								
Chlorella (5.9 g.)	2.5	1.3	1.4	0.7	30,000	0.02	0.15	21
Wheat flour (89.3 g.)	12.3	1.7	74.6	0.7	0	0.3	0.05	0
Yeast (0.5 g.)	0.23	0.03	0.2	0.04	0	0.05	0.02	0
Sugar (1.5 g.)	0	0	1.5	0	0	0	0	0
Salt (2.8 g.)	0	0	0	2.8	0	0	0	0
Noodles:								
Chlorella (6.1 g.)	2.6	1.3	1.5	0.7	30,000	0.02	0.15	21
Wheat flour (91.8 g.)	12.6	1.7	76.7	0.7	0	0.3	0.05	0
Salt (2.1 g.)	0	0	0	2.1	0	0	0	0
Ice cream:								
Chlorella (9.9 g.)	4.2	2.2	2.4	1.2	50,000	0.04	0.25	35
Evaporated milk (37.0 g.)	9.6	11.3	13.8	2.3	270	0.1	0.5	1.4
Milk (7.5 g.)	2.0	2.0	3.0	0.5	53	0.03	0.1	1.3
Flour (10.8 g.)	1.5	0.2	9.0	0.1	0	0.03	0.01	0
Eggs (3.4 g.)	1.7	1.5	0	0.2	110	0.01	0.04	0
Sugar (31.4 g.)	0	0	31.4	0	0	0	0	0

As may be seen from these figures, addition of chlorella causes an increase of 20% in protein and 75% in fat in the case of bread and noodles, and about 30% in protein and 15% in fat in the case of ice cream. Noteworthy is the fact that by the addition of algae the foods are made considerably richer in vitamins A and C, which are lacking in ordinary breads and noodles. The amino acid, sugar, and vitamin contents of the chlorella powder are given in Tables 2, 3, and 4, respectively.[a]

TABLE 2

Amino acids in chlorella cells

Amino acid	Fractions		
	Water soluble		Water insoluble; combined
	Free	Combined	
Essential:			
Leucine }	+++	++++	++++
Iso-leucine }			
Valine	++	+++	++++
Lysine	++	+++	+++
Threonine	++	+++	+++
Histidine	++	+++	++
Phenylalanine	++	++	+++
Arginine	+++	+	++
Tryptophane	−	++	++
Methionine	+	+(?)	++
Tyrosine	++	++	++
Cystine	+	+	+
Nonessential:			
Alanine	++++	++++	++++
Glycine	+++	+++	++++
Glutamic acid	++	+++	++++
Proline	+++	+++	+++
Aspartic acid	++	++	++++
Serine	++	+++	++
γ-Amino-butyric acid	+++	+	++(?)
β-Alanine	+	+	++
α-Amino-butyric acid	−	−	++
Citrulline	−	?	+
Unknown	+	+	+

TABLE 3

Sugars in chlorella cells

Sugar	Fractions		
	Water soluble	Water soluble, 80% alcohol insoluble	Water insoluble
Glucose	++	+++	++
Fructose (ketcheptose)	+++	±	+++
Xylose	++	+	+++
Galactose	++	?	++
Ribose and Ribulose	+	−	++
Triose	+	+	+
Sucrose	+	−	−
Phosphate esters	++		−
Gluconic acid	+		++
Ketogluconic acid	+		++
Galacturonic acid	−	±	++
Glucuronic acid	+		+

TABLE 4

Some vitamins found in chlorella cells

	Content per gram dry weight
Vitamin A	5000 International Units (as provitamin)
Vitamin B_1	4 γ
Vitamin B_2	21-28 γ
Vitamin B_6	9 γ
Niacin	176 γ
Folic acid	485 γ
Vitamin C	2000-5000 γ

SOME ATTEMPTS AT PROCESSING CHLORELLA POWDER

Simple methods of processing chlorella cells are suggested by those used in processing soybeans in Japan.

One of the most popular foods in both China and Japan is "tofu" or soybean curd, which is a clot of proteins (called "glycinin") prepared by coagulating the water extract of soybean by the action of magnesium or calcium salts (chlorides or sulfates). "Tofu" is white and by itself almost tasteless, although it contains, besides easily digested proteins, some fat and carbohydrate. Its appeal as food is largely due to its soft and delicate texture, as well as its neutrality, which permits it to harmonize with and set off the taste of other foods mixed with it. For these reasons it is used in almost all kinds of dishes in far Eastern countries. In the hope of getting a "tofu"-like product, the method used with soybeans was tested with a water decoction of chlorella powder, but unfortunately it proved totally unsuccessful. Obviously, this failure is due to the difference in nature of the proteins contained in different plants.

[a] The analyses of amino acids and sugars were made by S. Akabori and T. Fujiwara, of the University of Osaka; that of vitamins, by T. Uemura *et al.*, of the University of Tokyo. Details of their studies will be reported elsewhere by these workers.

Another suggested Japanese method is that of preparing a substitute "soy sauce" by hydrolysis of soybeans. Soy sauce is indispensable in preparing almost all kinds of Japanese foods; the authentic way of preparing it is by fermenting steamed soybeans (together with some wheat or rice) with salt and a mold, *Aspergillus oryzae*. Besides this mold, a number of bacteria and yeasts participate in the process of fermentative decomposition of various substances, which requires about one year for producing the typical color and taste of soy sauce.* Since this method is rather complicated and time-consuming, a short-cut chemical method is now being widely used in parallel with the authentic method. The soybeans are hydrolyzed with hydrochloric acid which is later neutralized with sodium hydroxide or sodium carbonate to give the appropriate amount of sodium chloride. The resulting sauce is almost identical in appearance and taste with genuine ones, although it lacks some essential savor. To conceal this defect, the sauce manufactured in this way is usually sold mixed with genuine soy sauce.

Using powdered chlorella cells, we attempted the chemical method of preparing a substitute for soy sauce. One hundred g. of chlorella powder was suspended in 200 ml. of 25 to 20% solution of hydrochloric acid in an Erlenmeyer flask provided with a condenser, and heated on a sand bath. Analysis of the solution for nitrogen indicated that about 5 hours' heating was sufficient for the hydrolysis to proceed to a desirable stage. After 5 to 15 hours' hydrolysis, the mixture was filtered and neutralized with sodium bicarbonate to pH 4.5-5.4. The solution thus obtained was almost exactly similar in appearance to real soy sauce, and showed the composition presented in Table 5. In this table the composition of typical genuine soy sauce as well as the prescribed standard for commercial "soy sauce" is also given for comparison.

When properly diluted, the hydrolysate of chlorella powder tastes almost the same as sauce prepared from soybeans by the chemical method. The taste was considerably improved when the following substances were added: lactic acid (0.2%), acetic acid (0.05%), succinic acid (0.005%), ethanol (0.01%), and sucrose (0.05%).

TABLE 5

Composition of chlorella hydrolysate as compared with that of genuine soy sauce and the standard for commercial "soy sauce"

	Genuine soy sauce	Chlorella hydrolysate	Standard for commercial "soy sauce"
Nonaq[illegible]us substances	36.9%	41.2%	.....
Total nitrogen	1.22%	2.29%	>0.7%
Amino nitrogen	0.42%	1.42%	.....
Sodium chloride	18.9%	22.1%	>17.0%
Specific gravity	23.2 Bé	25.5 Bé	>17.5 Bé

These experiments show that the preparation of a substitute for soy sauce is a very promising way of using chlorella cells.

TASTE OF OTHER UNICELLULAR ALGAE

A few experiments conducted with dried powder of *Chlorella pyrenoidosa*, Emerson's strain, showed that it tastes almost exactly the same as the strain of *C. ellipsoidea* we have used. We also found that dried materials of scenedesmus, chlorococcum, and even a sea-water alga, *Dunaliella salina*, taste almost the same as chlorella. It may well be expected that the methods used with chlorella may also be applied successfully to these different kinds of unicellular algae.

SUMMARY

Dried powder of chlorella cells shows a taste and flavor similar to those of powdered green tea and powdered dry "aonori," a seaweed *(Enteromorpha compressa)* commonly used as a seasoning in Japanese cookery. It was found that the algal powder can be added to various kinds of food, both Western and Japanese, giving them an agreeable taste and appearance and increasing their protein, fat, and vitamin content. An attempt at extracting a "tofu"-like material from chlorella cells failed, but by hydrolysis of algal powder a solution was obtained which may be used as a substitute for soy sauce.

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* Main components in the taste of soy sauce are various amino acids (especially glutamic acid), sodium chloride, various amines, and other nitrogenous substances. Its characteristic flavor is due to various unsaturated ketones, aldehydes, and alcohols, among which the most important factor was found to be γ-methyl-mercapto-propylalcohol.

The Optimal Harvest Time of Pea Canning and Freezing Crops in New York State. I. The Definition of Optimal Harvest Time

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Investigations of maturing pea crops suggest that the greatest yield of first quality freezing peas coincides with a Maturometer Index value of 195. This Index is the reading of a representative ungraded sample of peas on the Maturometer, an instrument for the rapid determination of maturity, developed in Australia. The result for canning peas was inconclusive, but when considered in the light of previous work, a Maturometer Index value of 250 is probably a close approximation to the optimal harvest time. Both values were determined by an analysis of daily yields from randomized plots harvested during the last eight to ten days of the maturation period, and from an analysis of records for acceptability of canned and frozen samples presented to a taste panel. Further investigation is desirable to confirm the validity of these conclusions.

Investigations of the behavior of pea canning crops during the immediate preharvest period were carried out by Lynch and Mitchell *(1, 2)* over a number of seasons in Australia, and the conclusion was reached that the optimal harvest time (O.H.T.) could be defined as the point in crop development which coincided with greatest yield of first quality peas. First quality peas were also defined by a series of taste tests as those lying within the 11 and 16% alcohol insoluble solids limits. This stage of maturity in canning peas was indicated by a Maturometer Index (M.I.) value of 250, this value being the reading on the Maturometer scale of an ungraded representative sample from which peas smaller than size grade 2 have been removed.

With the possible exception of the Pacific Northwest area, climatic conditions for the growth of processing pea crops in America differ so greatly from those prevailing in Australia, that the possibility of differences in the general behavior pattern of maturing crops in the two countries is evident. An invitation was consequently extended to Australian workers by the New York State Agricultural Experiment Station to demonstrate their techniques with crops grown in the Geneva area of New York State. This paper presents the results of the Geneva investigation, which was conducted during the 1953 pea season. For convenience, results are expressed in relation to the O.H.T. determined for Australia. This procedure does not assume that an identical O.H.T. is necessarily applicable in America.

EXPERIMENTAL PROCEDURE

An experimental area of one acre was sown each to Thomas Laxton and to Perfection peas. The soil was an Ovid silt loam (pH 6.5), the seeding rate was 3.9 bushels per acre, and 580 lbs. of 10-10-10 fertilizer was drilled in previous to planting. A uniform area within the Laxton crop was divided into 10 blocks, each of which was further subdivided into 14 plots of size 91 in. by 70 in., and provision was made for 14 in. of guard row between plots. The Perfection crop was divided into 6 blocks, each containing 14 plots of size 161 in. by 126 in. with 14 in. guard rows.

The vines from 10 plots selected at random in the Laxton crop were harvested daily by hand and bulked. Vines were similarly harvested from the Perfection crop, but the product of each of the six plots was individually treated in subsequent operations.

Vines from each experiment were weighed to the nearest 1 lb. They were passed through a commercial viner at controlled beater speeds varying from 150 to 160 r.p.m. to avoid excessive damage, with resultant loss of peas through splitting and undue effect on Maturometer readings as demonstrated by Moyer, Lynch and Mitchell *(4)*.

Peas recovered from the viner were treated in a dry cleaner, and peas smaller than size grade 2 were removed in a vibratory screen and weighed for total yield. Weights of individual size grades were recorded after further screening.

Ungraded and graded pea samples were submitted for Maturometer determination, the former being recorded as Maturometer Index (M.I.), and the latter as Maturometer value. In all cases the mean of 4 separate readings was recorded. When sufficient peas were available, samples were also tested in duplicate by Tenderometer.

Within each size grade 100 peas were weighed in duplicate to 0.1 g., to enable conversion of pea yields by weight to numerical values.

The unused portions of the Thomas Laxton and Perfection plantings were mechanically harvested in strips daily, to provide peas in bulk for freezing or canning, for alcohol insoluble solids (A. I. S.) determinations, and for submission to taste tests. These peas were tested by Maturometer, and processed ungraded and graded for freezing, and graded for canning.

A range of 12 samples of frozen peas from 9.3 to 18.9% A. I. S. was submitted to the taste panel in two series, in each of which the samples differed from each other progressively by approximately 2% A. I. S. Sample presentation was in the form of a latin square, using 6 A. I. S. levels and 6 sittings, the order of presentation being such that any one level of A. I. S. followed any other level on not more than one occasion. The canned peas taste test was similar in design, using five A. I. S. levels in the range 9.3 to 14.4%, and 5 orders of presentation.

The taste panel consisted of 16 members, but some of these were unable to attend regularly. Numbers of tasters in the final analysis therefore varied from 12 to 14. Tasters were requested to score in the range 1 to 5 primarily for personal acceptability, 1 being rated as low and 5 as high. The panel was asked to avoid interrelation in the judgment of canned and frozen samples.

RESULTS

Gross vine weights are given in Table 1 with the exclusion of those which were affected by rain. An analysis of variance of the Perfection crop data showed an absence of significance of yields with time, the variance ratio being 1.22. An inspection of the records for Thomas Laxton suggests that the result was similar.

Pea yields for Thomas Laxton are shown in Table 2. The following highly significant linear regression was derived for change in total yield (lb./ac.) (Y) with time (D) in days from O. H. T. Before O. H. T., D is negative.

$$Y = 437.73\ D + 3436 \qquad \text{S. E. of Estimate} = 111.8$$

An analysis of variance of total yield of the Perfection crop to 2 days beyond O. H. T. (Table 3) showed a high degree of significance between days, and an absence of significance between blocks. The following regression was obtained for change in total yield (lb./ac.) with time in days from O. H. T.:

$$Y = 450.74\ D + 3040 \qquad \text{S. E. of Estimate} = 220.0$$

When analyzed statistically, all size grades in both crops were found to give highly significant regressions for yields with time, but in the case of size grade 2 a small but significant unexplained variation remained beyond the quintic regression.

Maturometer Index determinations and Maturometer values for both crops are set out in Tables 4 and 5. Quadratic regressions for change in M. I. of Thomas Laxton with time in days from O. H. T. (D), where D is negative before O. H. T., are as follows:

$$\text{M. I.} = 250 + 43.4\ D + 3.145\ D^2$$
$$\text{S. E. of Estimate} = \pm 17.08$$

The regression for Perfection variety is:

$$\text{M. I.} = 250 + 40.7\ D + 3.231\ D^2$$
$$\text{S. E. of Estimate} = \pm 23.42$$

When graphed to coincide at M. I. 250 these regressions do not differ significantly.

Tenderometer readings for both crops are shown in Tables 6 and 7. Records are incomplete because of shortage of raw material.

Weights of 100 peas in each size grade are given for Thomas Laxton and Perfection in Tables 8 and 9 respectively. These weights were used to convert pea yields of size grades shown in Tables 2 and 3 to pea numbers, which were combined with Maturometer values of size grades in Tables 4 and 5 for the estimation of a weighted mean Maturometer Index. Calculated values of this factor are presented together with experimentally determined values in Tables 4 and 5.

TABLE 1
Gross vine weights

Days to O. H. T.	Thomas Laxton		Perfection	
	lb. per plot	lb. per acre	lb. per plot	lb. per acre
−7	18.7	18500	....	....
−6	[1]	[1]	49.3	15100
−5	18.1	17900	62.2	19200
−4	17.7	17500	[1]	[1]
−3	19.1	18800	44.7	13900
−2	18.5	18300	49.3	15800
−1	17.0	16800	50.7	15800
0[2]	18.1	18000	45.0	13900
+1	17.6	17400	49.5	15100
+2	18.8	18600	48.0	14800

[1] Vines wet due to rain.
[2] Nearest day to O. H. T.

TABLE 2
Pea yield (lb. per acre). Thomas Laxton

Days to O. H. T.	Size Grades						Total
	2	3	4	5	6	7	
−8	....	....	....	....	....	....	60
−7	85	182	43	2	....	....	313
−6	68	303	226	15	....	....	613
−5	80	485	485	73	3	....	1127
−4	68	454	654	303	13	....	1492
−3	28	432	851	810	112	2	2236
−2	28	316	734	1001	409	11	2498
−1	25	179	653	1311	767	36	2971
0	17	199	710	1431	972	65	3394
+1	28	66	422	1480	1609	147	3752
+2	2	63	320	1404	2233	265	4287

TABLE 3
Mean pea yield (lb. per acre). Perfection

Days to O. H. T.	Size Grades						Total
	2	3	4	5	6	7	
−6[1]	....	....	....	....	....	....	250
−5	54	274	66	....	....	....	335
−4	125	737	301	22	....	....	1185
−3	131	858	415	31	1	....	1435
−2	96	886	802	103	14	....	1901
−1	62	874	1207	302	18	....	2463
0	117	690	1549	606	45	....	3007
+1	18	448	1561	1243	138	4	3412
+2	15	362	1515	1384	221	13	3511

[1] Insufficient yield for size grade determination.

TABLE 4
Maturometer values of size grades. Thomas Laxton

Days to O. H. T.	Size Grades						M. I.	M. I. (calc.)[1]
	2	3	4	5	6	7		
−7	84	105	123	**	....	....	103	101
−6	103	120	140	149	....	....	116	124
−5	101	118	147	186	**	....	121	128
−4	91	109	150	187	204	....	137	138
−3	99	111	136	176	231	**	144	144
−2	97	114	150	186	227	240	162	164
−1	103	116	158	210	265	276	179	198
0	136	146	201	248	294	307	240	237
+1	**	189	225	302	373	405	313	316
+2	**	209	262	329	390	442	352	353

[1] Calculated weighted mean from Maturometer values and numbers of peas in size grades.
** Insufficient yield for Maturometer determination.

TABLE 5
Mean Maturometer values of size grades. Perfection

Days to O. H. T.	Size Grades						M. I.	M. I. (calc.)[1]
	2	3	4	5	6	7		
−6	119	154	....	....	....	....	118	....
−5	109	128	134	**	....	....	124	135
−4	120	145	181	218	....	....	144	153
−3	132	156	156	237	**	....	160	162
−2	125	151	180	247	**	....	163	169
−1	129	159	209	264	270	....	188	196
0	145	187	251	312	359	....	230	237
+1	196	222	269	322	372	**	282	279
+2	229	291	352	401	436	**	342	362

[1] Calculated weighted mean from Maturometer values and numbers of peas in size grades.
** Insufficient yield for Maturometer determination.

TABLE 6
Tenderometer values of size grades. Thomas Laxton

Days to O. H. T.	Size Grades						Ungraded
	2	3	4	5	6	7	
−7	....	74	....	....	....	....	72
−6	....	83	84	....	....	....	82
−5	70	77	84	89	....	....	81
−4	62	78	86	91	....	....	85
−3	....	77	85	93	....	....	88
−2	....	81	85	97	99	....	91
−1	....	82	92	99	112	....	97
0	....	91	100	111	121	....	115
+1	....	....	113	126	136	144	131
+2	....	....	126	138	145	152	142

Mean Tenderometer values of size grades. Perfection
Mean tenderometer values of size grades. Perfection

Days to O. H. T.	Size Grades						Ungraded
	2	3	4	5	6	7	
−6	....	....	....	....	....	....	....
−5	....	....	....	....	....	....	....
−4	....	....	....	....	....	....	....
−3	....	82	96	....	....	....	88
−2	....	86	93	....	....	....	94
−1	....	89	101	113	....	....	99
0	....	110	121	130	....	....	115
+1	....	121	132	145	....	....	132
+2	....	129	145	156	163	....	143

Agreement between M. I. found by these two methods is remarkably close as for each pair 4 separate series of measurements are required, viz., measured M. I., Maturometer readings of each size grade, weight of each size grade, and weight of 100 peas. This agreement shows that in testing a mixed sample each pea, irrespective of size and maturity, contributes to the Maturometer reading, which is, therefore, the sum of the maturities of all the peas. The M. I. thus expresses the average maturity of the crop provided sampling is adequate.

TABLE 8

Mean weight (g.) of 100 peas in size grades. Thomas Laxton

Days to O. H. T.	Size Grades					
	2	3	4	5	6	7
−7	27.3	32.8	41.1	.....	.....	.....
−6	26.4	33.1	41.1	.....	.....	.....
−5	27.8	34.0	43.2	53.4	.....	.....
−4	.....	33.5	42.7	53.8	61.1	.....
−3	28.7	34.6	44.7	55.1	64.3	64.9
−2	27.5	33.6	43.0	55.4	65.7	69.0
−1	28.1	35.0	45.3	56.6	67.3	74.8
0	28.2	35.6	46.0	56.3	68.0	69.7
+1	25.7	33.7	45.3	58.6	70.7	80.1
+2	.....	33.8	45.2	58.5	69.6	75.7

TABLE 9

Mean weight (g.) of 100 peas in size grades. Perfection

Days to O. H. T.	Size Grades				
	2	3	4	5	6
−5	24.0	28.8	.....	.....	.....
−4	26.2	30.8	38.5	.....	.....
−3	26.0	31.3	38.8	45.8	.....
−2	25.1	33.3	39.0	48.8	.....
−1	26.2	32.3	39.8	47.7	.....
0	23.8	31.6	40.2	47.8	52.6
+1	24.2	31.7	40.2	48.1	54.4
+2	24.5	32.1	41.1	49.7	57.2

A series of correlations for Maturometer and A. I. S., Maturometer and Tenderometer, and Tenderometer and A. I. S. was obtained. The correlation coefficient for all values of Maturometer (M) and Tenderometer (T) from both crops was $r = +0.97$ (258 pairs of observations). The corresponding regression equation was:

$$T = 0.27\ M + 50 \qquad \text{S. E. of Estimate} = 5.9$$

The correlation coefficient for Maturometer and Tenderometer values of Laxton peas was $r = +0.96$, and for Perfection peas a correlation $r = +0.98$ was obtained. These were derived from 112 and 146 pairs of observations, respectively.

When Maturometer readings were related to A. I. S. of Laxton peas the correlation $r = +0.97$ (57 pairs) was obtained, and the regression equation was:

$$M = 23.5\ \text{A. I. S. (frozen)} - 86$$
$$\text{S. E. of Estimate} = 24.4$$

The remaining correlations were:

Tenderometer and A. I. S. (frozen)
$r = +0.91$ (47 pairs)

Tenderometer and A. I. S. (canned)
$r = +0.96$ (16 pairs)

Maturometer and A. I. S. (canned)
$r = +0.91$ (21 pairs)

Taste test results for Thomas Laxton peas showed very high significance for A. I. S. levels with a marked downward trend in acceptance at about 14.5%. There was no indication from combined scores of the recognition of immaturity as a limiting factor in acceptance. Taste tests with Perfection peas showed significance for A. I. S. levels, order of presentation, tasters, and the interaction of tasters and A. I. S. levels. In one of the tests, sittings proved to be non-significant at the 5% level, but this factor was highly significant in the other.

Data from pea yields and taste tests of Laxton peas were used for the development of the yield summation graph shown in Figure 1. The graph illustrates the quantitative relationships of yields of size grades to each other, and to total yield for successive daily harvests. Superimposed on the graph in terms

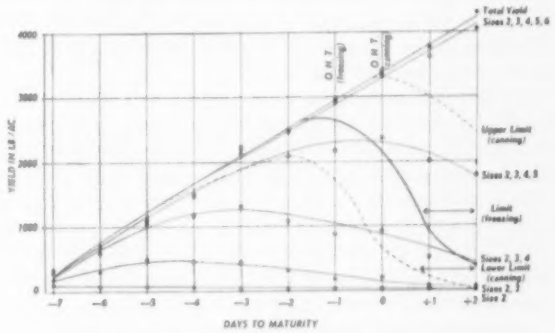

Figure 1. Yield summation graph. Laxton peas.

of yield are the upper and lower quality limits for canned peas as determined from Australian work, and these indicate, by the vertical interval between them, good agreement with the predetermined M. I. 250 value for the O. H. T. The upper quality limit line determined for frozen peas at the 14.5% A. I. S. level from the New York investigation is also shown. Figure 2 is

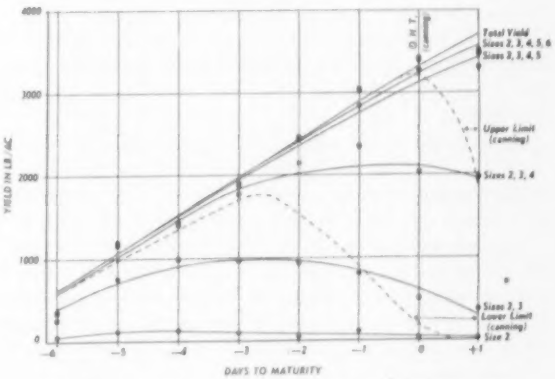

Figure 2. Yield summation graph. Perfection peas.

the yield summation graph for the Perfection crop, and because of the inconclusive nature of the taste tests at Geneva, the upper and lower quality limit lines from Australian work only are shown.

DISCUSSION

The general developmental pattern of maturing Thomas Laxton and Perfection peas in New York State was essentially similar to that previously obtained *(1, 2)*. Reference to Figures 1 and 2 show daily yield transformations in size grades, and the functional linearity of total yield with time. The superimposed quality limit lines applicable from Australia taste tests with canned peas indicated that greatest yield of first quality peas occurred a fraction of a day beyond M. I. 250.

Changes in M. I. with time were found in Australia to be linear, being of the order of 20 lbs. increase in the Maturometer reading per day, except in a few isolated cases when accelerated maturation rates were thought to be caused by plant injury *(3)*. Both crops investi-

gated at Geneva gave overall increases in rate of maturation well above the values previously determined for normal crops. This aberrant behavior could be explained by extensive root rot infection which was present in the crops studied. The maturation rate took the form of a quadratic regression with small daily increases in the less mature stages rising to about 40 lbs. as the crops approached M. I. 250.

Tenderometer studies were undertaken when sufficient raw material was available, in order to compare the performance of Tenderometer and Maturometer, and to assess their individual relationships with A. I. S. values of comparable samples. A complete series was obtained for Tenderometer values of ungraded Laxton peas but not for Perfection. Because of omissions in records of size grades for both crops, it was not possible to calculate a weighted mean of ungraded samples for comparison with experimentally determined Tenderometer values.

The relationships of various measures of pea maturity to each other were determined in Australia by Lynch and Mitchell *(1)*. Work at Geneva emphasized the consistently high correlations which were obtained, when due regard was given to the preparation of the sample for physical or chemical determination.

Regression equations for Tenderometer and A. I. S. (frozen and canned), and for Maturometer and A. I. S. (canned) were not quoted under the section on results, because there were not enough observations to constitute adequate samples over the full range of crop maturities.

The absence of significant change of gross vine weights with time confirmed the earlier conclusion that adequate sampling of a crop of peas on any immediate preharvest day can provide useful data with respect to transport and viner loads. The results may be interpreted as indicating that loss in net weight of vines is counterbalanced by increase in weight of peas and pods.

Further confirmation was given by Geneva investigations of the linear function of total yield with time to one day beyond O. H. T.

Results of taste tests with frozen Thomas Laxton peas provided an upper limit of first quality corresponding to 14.5% A. I. S. (frozen), which is equivalent to a Maturometer value of 254. No lower limit involving recognition of immaturity was detectable, and the total area below the upper limit line in Figure 1 may therefore be regarded as constituting first quality peas for freezing purposes. For comparison the 11 and 16% A. I. S. limits for first quality canned peas which were determined from Australian work are also shown in the graph. The deviation of the value for frozen peas from these limits was not unexpected.

Figure 1 shows that the greatest yield of first quality Laxton peas occurred 1.3 days before the O. H. T. recorded in Table 2. This point corresponded with an M. I. value of 195 on the day of harvest, which was equivalent to 12% A. I. S. (frozen). The value for Tenderometer reading was 95. From Table 2 and Figure 1 the calculated yield of first quality peas at M. I. 195 was 2700 lbs. per acre, and the gross yield was 2810 lbs. per acre.

Taste test results with Perfection peas failed to show distinct differences between A. I. S. levels, and these were found to be of no greater importance than the order in which the samples were presented. It is possible that the expressed preference of tasters for frozen as compared with canned peas may have influenced this result. The limited range of maturity in the samples presented was apparently the most important contributory factor. The exclusion of older peas from the test indicated that, while the result was inconclusive, the upper limit for first quality was not attained. This suggested that the upper limit of 16% A. I. S. from Australian tests would not differ greatly from local standards for acceptance. As in the case of Laxton peas, no lower limit of first quality was demonstrated by the tasters. Pending further clarification, therefore, the greatest yield of first quality peas could be considered on the basis of the 16% upper limit line to occur 0.9 days after the O. H. T. indicated in Table 3. This point corresponds with M. I. 260 which is slightly higher than the M. I. 250 value at O. H. T. determined under Australian conditions. The total yield of Perfection peas at M. I. 260 was 3247 lbs. per acre and the yield of first quality peas was 3220 lbs. per acre.

SUMMARY

The technique of investigation of pea processing crops developed in Australia was found to be suitable without modification for the work at Geneva. Maturation rate was considerably greater in the crops studied. Whereas the M. I. relation with time was found previously to be essentially linear, a quadratic curve for this relationship was derived from the results of the New York State investigation.

A tentative O. H. T. at M. I. 195 was obtained for Thomas Laxton peas which are grown as a freezing variety, while the tentative value for Perfection peas grown for canning was M. I. 260. These confirmed that freezing peas should be harvested at a less mature stage than canning varieties, but because of the rapid daily increase in yield over the last preharvest period, data contained in Tables 2 and 3 demonstrate the need to harvest as closely as possible to the O. H. T. In order to do so it is necessary to adopt a precise method of prediction of O. H. T., and this subject will be presented in Part 2 of this contribution.

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The Optimal Harvest Time of Pea Canning and Freezing Crops in New York State. II. The Short Term Prediction of Optimal Harvest Time

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The short term prediction of optimal harvest time of canning and freezing pea crops is based on the ability to assess the maturity of a crop at any preharvest stage, a knowledge of the best time to harvest, and precise information with respect to the maturation rate. Using basic data presented in the first part of this contribution, harvest predictions were made on six crops grown at Geneva, N. Y. Results showed that the prediction method can be successfully applied to the field control of commercial pea crops.

Several useful long term procedures for the prediction of the time of harvest of pea crops have been developed, chiefly for the purpose of regulating plantings for the avoidance of gluts at harvest. No corresponding accurate method for the short term prediction of the harvest time has been evolved, in America, though the heat unit system with and without modification has been used for this purpose. In the first paper in this series *(3)* the optimal harvest time (O. H. T.) based upon the point in crop development corresponding to greatest yield of first quality peas, was derived from a study of daily yields and an analysis of taste tests of a maturity range of canned and frozen samples. The use of the Maturometer Index (M. I.) of an ungraded representative sample of peas was shown also, to indicate the maturity of a crop as a whole, by reason of its close agreement with a weighted mean value derived from the Maturometer readings and numbers of peas in constituent size grades of the same sample. The earlier paper also showed that a very highly significant quadratic regression could be obtained for the rate of change of M. I. under the conditions of the experiment. These results are similar to those previously obtained *(1, 2)*, except that under Australian conditions the rate of change in most cases was found to be essentially linear. The few crops found to conform in Australia with the quadratic curve were subject to injury, and formed the initial basis for the tentative conclusion that maturation rate in many American pea crops is accelerated by the presence of one or more of the organisms responsible for root rot, and in some areas by the occurrence of pea virus.

Six crops were used for the prediction of O. H. T. at Geneva, N. Y. and the results of these investigations are presented in this paper.

EXPERIMENTAL PROCEDURE

Crops were sampled for prediction of O. H. T. by hand pulling all the vines in an approximate area of one square yard at each of 4 points equally spaced along the longest dimension of the field. The bulked vines were fed into a viner operating at a closely controlled speed *(3)*, and the vined peas were dry cleaned. Peas smaller than size grade 2 were removed in a vibratory screen, and the mean of 4 Maturometer determinations on the well mixed sample was recorded as the M. I.

The 4-point sample procedure is convenient in practice, but nevertheless involves a field sampling error of some magnitude. The practice was therefore adopted of averaging the M. I. values on successive days to reduce the error of the sample. This running mean was restricted to three days to retain the sensitivity of the sampling procedure to current changes in weather. The 4-point and 3-day mean method of prediction was shown to operate satisfactorily over a wide range of crops tested in Australia *(1, 2)*. Prediction of O. H. T. at Geneva was based on M. I. 250 for all crops, and recorded data were later used for prediction of the M. I. 195 endpoint.

Five crops were grown at the Canning Crops Farm and one at the Heinzman Farm of the Geneva Experiment Station, and the varieties tested were Thomas Laxton, Shoshone and Perfection. One Perfection crop was subdivided into nitrogen and no nitrogen treatments, to assess the reputed ability of nitrogenous fertilizer to retard maturation rate.

A standard crop prediction chart is shown in detail in Table 1.

TABLE 1

Crop prediction chart. Thomas Laxton

Date of Sample	M. I.	M. I. Mean	Days to O. H. T.	Harvest Prediction
6/20/53	89	89	—8.0	6/28/53
6/21/53	103	96	—7.2	6/28/53
6/22/53	116	103	—5.5	6/28/53
6/23/53	121	113	—4.5	6/28/53
6/24/53	137	125	—3.6	6/28/53
6/25/53	144	134	—2.9	6/28/53
6/26/53	162	148	—2.1	6/28/53
6/27/53	179	162	—1.5	6/28/53
M. I. at harvest		Actual	240	
		Predicted	232	

Predictions were based on the following mean quadratic regression equation, which was derived from the separate quadratic regressions for M. I. change with time in days (D) from O. H. T. quoted in Part I of this paper. Before the O. H. T. D is negative.

$$\text{M. I.} = 250 + 42.1\ D + 3.19\ D^2$$

The curve representing this formula may be graphed and the number of days to O. H. T. for any M. I. read directly from it. However, for convenience, predictions were calculated in practice from the following sliding M. I. scale, which was derived from the quadratic regression:

Mean M. I. Crop Value	Daily M. I. Prediction Value
81-100	20.0
101-110	22.5
111-120	25.0
121-130	27.5
131-140	30.0
141-150	32.5
151-230	35.0
230-250	40.0

When the M. I. used is the mean of two or three successive days' readings, it obviously applies to the mid-point in time and the prediction must be adjusted accordingly. For the first three days' M. I. mean value for the crop shown in Table 1, the following predictions are calculated from the sliding scale.

M. I. mean 89. $\frac{250 - 89}{20} = 8.05$ days to O. H. T. since one

day's observation only is contained in the M. I., mean no time adjustment is necessary.

M. I. mean 96. $\frac{250 - 96}{20} = 7.7$ — 0.5 day to O. H. T. since two days' observations are contained in the M. I. mean.

M. I. mean 103. $\frac{250 - 103}{22.5} = 6.5 - 1.0$ days to O. H. T. since three days' observations are contained in the M. I. mean.

The following general formula may be used for calculation of days from O. H. T.

$$-D = \frac{250 - \text{M. I.}}{R} - \frac{n - 1}{2}$$

Where D = days
M. I. = M. I. mean
n = number of days' readings in M. I. mean
R = appropriate M. I. prediction value from sliding scale

RESULTS

Details of the 6 crops studied are summarized in Table 2 including the relationship between actual and predicted M. I. values at harvest. The second Laxton crop showed a deviation of 36 in M. I. value from the final figure predicted. This difference was equivalent to —0.9 day error in prediction.

In the 5 remaining crops the errors expressed in days were respectively —0.2, —0.4, +0.1, +0.4, and +0.2.

The analysis of data from maturing Thomas Laxton crops at Geneva when combined with the results of taste tests of the frozen samples indicated that the greatest yield of first quality peas occurred at M. I. 195. Since all 6 crops were amenable for prediction to M. I. 250 by the same sliding scale, they were all tested to M. I. 195 by the selection of the appropriate section of the mean quadratic equation for change in M. I. with time. The following sliding scale was used for this purpose:

Mean M. I. Crop Value	Daily M. I. Prediction Value
81-120	15
121-195	20

Results of prediction to M. I. 195 are also given in Table 2.

The Perfection (nitrogen) crop showed a deviation of 24 in M. I. value from the final figure predicted, and this was equivalent to an error of —1.2 days in prediction on the basis of the sliding scale. When calculated from the quadratic regression the error was —0.6 day. The errors of prediction in the 5 remaining crops were +0.4, +0.1, —0.4, +0.3, and +0.4 respectively.

DISCUSSION

Data from prediction tests showed that despite an accelerated maturation rate in crops at Geneva, as compared with those previously experienced, they were nevertheless capable of prediction within practical limits. There was some evidence of retardation of maturation due to nitrogenous fertilizer, though the rate of maturation over the final preharvest period did not appear to be affected. The sliding scales used for prediction at M. I. 250 and M. I. 195 are tentative only, in view of the very small numbers of observations included in this investigation. It is possible also that maturation rate may differ in different pea growing areas and in other seasons, or with differences in the type and quantity of root rot infection. There is, however, significance in the fact that injured crops in Australia and Geneva both conform with the quadratic regression for maturation rate; this suggests that differences in the degree of injury may not seriously affect the procedure for the practical prediction of commercial crops. Further investigation is indicated to obtain confirmation of this point.

SUMMARY

The approximate mean errors of prediction of a number of crops based on harvest at M. I. 250 and M. I. 195 were, respectively, 0.3 and 0.5 day. These errors are well within the practical limits of factory operation.

Acknowledgments

This work was carried out with the cooperation of the Heads of the Divisions of Vegetable Crops and Food Science of the N. Y. State Agricultural Experiment Station. In particular our thanks are due to Dr. W. S. Ryder, Jr., Dr. J. C. Moyer, Mr. J. C. Hening, Miss Joanne Whitcombe, and Miss M. L. Andrews for valuable assistance in various phases of the investigation.

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TABLE 2
Summarized results of six crop predictions

Laxton				Laxton				Perfection (nitrogen)				Perfection (no nitrogen)				Shoshone				Perfection			
		Days to				Days to				Days to				Days to				Days to				Days to	
M. I.	M. I. Mean	M. I. 250	M. I. 195	M. I.	M. I. Mean	M. I. 250	M. I. 195	M. I.	M. I. Mean	M. I. 250	M. I. 195	M. I.	M. I. Mean	M. I. 250	M. I. 195	M. I.	M. I. Mean	M. I. 250	M. I. 195	M. I.	M. I. Mean	M. I. 250	M. I. 195
89	89	—8.0	—7.1	133	133	—3.9	—3.1	128	128	—4.4	—3.3	132	132	—3.9	—3.1	109	109	—5.6	—5.7	118	118	—5.3	—5.1
103	96	—7.2	—6.1	148	140	—3.2	—2.5	172	150	—2.6	—1.7	184	158	—2.1	—1.4[1]	104	107	—5.2	—5.3	124	121	—4.1	—4.4
116	103	—5.5	—5.1	169	150	—2.1	—1.2[1]	192	164	—1.5	—0.5[1]	196	171	—1.3[1]		127	113	—4.5	—4.5	144	129	—3.4	—2.3
121	113	—4.5	—4.5	188	168	—1.3[1]		224	196	—0.6[1]		238				147	126	—3.4	—2.4	160	143	—2.3	—1.6
137	125	—3.6	—2.5	274				282								171	148	—2.2	—1.3[1]	163	156	—1.7	—0.9[1]
144	134	—2.9	—2.0													182	167	—1.4[1]		188	167	—1.4[1]	
162	148	—2.1	—1.3[1]													222				230			
179	162	—1.5[1]																					
240																							
Prediction to M. I. 250																							
Actual 240						274				282				238				222			230		
Predicted 232						238				266				241				237			237		
Prediction to M. I. 195																							
Actual 179						188				224				196				182			188		
Predicted 188						190				204				188				188			196		

[1] Harvest next day.

Observations on Rate of In-Package Desiccation

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(Manuscript received August 14, 1953)

Observations on rate and extent of in-package desiccation of 5 dehydrated vegetables at temperatures of 75°, 100°, and 120° F. (24°, 38°, and 49° C.) are reported. Increases in rates of desiccation of approximately 2- to 3-fold per 18° F. (10° C.) of temperature increase were found. The implications of the results obtained are discussed.

A companion paper *(3)* presents the results of a large-scale study of the effectiveness of in-package desiccation (IPD) in maintaining the quality of dehydrated vegetables during storage. This paper is concerned with the rate and extent of desiccation in that study. Fairly extensive desiccation before exposure to elevated storage temperature will usually be necessary if maximum protection is to be obtained from in-package desiccation. The data here shown may be of value where applications of in-package desiccation—for either civilian or military use—are contemplated. The experimental conditions are described in the companion paper *(3)*.

RESULTS

Figures 1, 2, and 3 show the course of desiccation of the dehydrated white potato, cabbage, and carrot, respectively, in cans of approximately 4¾-inch height. The samples had been held at 75° F. (24° C.) for 21 to 25 days before transfer of some of them to higher temperature. Points on the graphs represent average moisture contents as determined for duplicate packages. The moisture contents were determined by the method of Makower, Chastain, and Nielsen *(4)* and are expressed on a moisture-free basis (MFB).

Effect of temperature. It is evident that storage temperature has considerable effect on the rate of desiccation and also on the extent of desiccation attainable within periods up to 5 months. Data on the effect of temperature are given in Table 1, which shows number of days required for given changes in moisture content. These values were read from plots such as those in Figures 1 to 3. Plots of the logarithms of these time values vs. the reciprocal of the absolute temperature are approximately straight lines; from these lines it is estimated that the rate of desiccation is increased approximately 2.1- to 3.2-fold by a temperature increase of 18° F. (10° C.). Knowledge of this temperature coefficient is important in conjunction with that for the browning reaction as an aid in planning time-temperature conditions for the storage of dehydrated vegetables.

Variation with kind of vegetable. Desiccation of the dehydrated carrot (Figure 3) was much slower than that of white potato and cabbage (Figures 1 and 2). This low rate of desiccation is responsible for the fact that the full-dice carrot used in these studies received less protection against browning than did the other vegetables *(3)*. The slow and incomplete desiccation of the carrot was not due to insufficient desiccant, since the desiccant samples removed from sample cans after storage had substantial remaining capacity to absorb moisture. Slow desiccation was found with a second lot of dehydrated carrot, in this instance of half-dice size (⅜ x ⅜ x 3/16-inch before dehydration).

Effect of container size. Figure 4 shows the course of in-package desiccation in dehydrated white potato half-dice packed

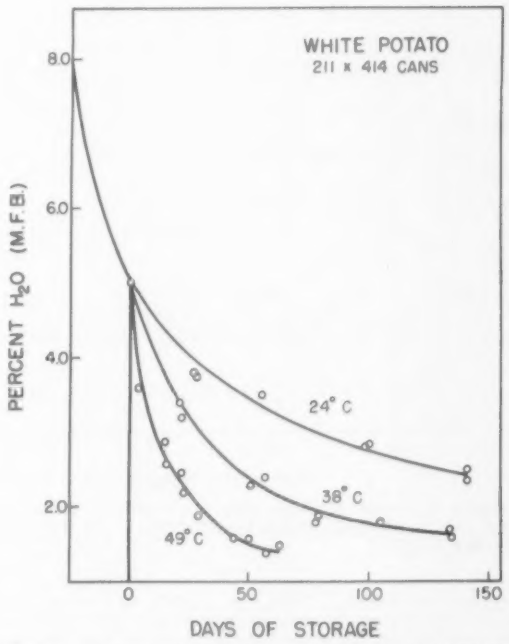

Figure 1. Course of in-package desiccation of dehydrated white potato (¾" x ¾" x 3/16" before dehydration) in 211 x 414 cans (4⅞-inch height).

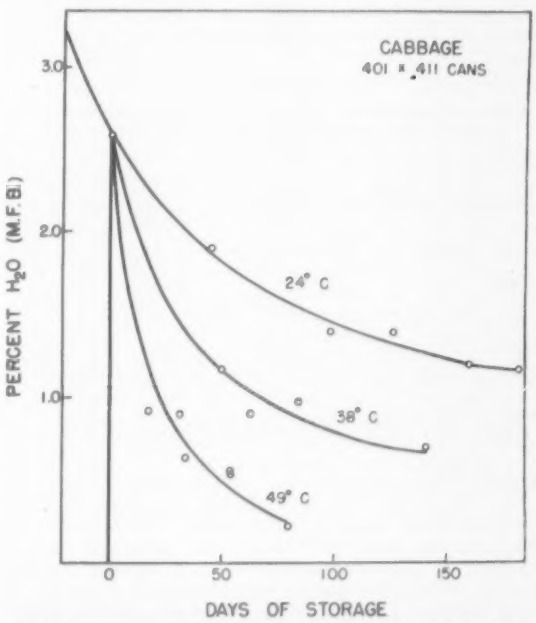

Figure 2. Course of in-package desiccation of dehydrated sulfited cabbage in 401 x 411 cans (4 11/16-inch height).

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in 5-gallon cans (13.75-inch height) with the desiccant package at the bottom of the container. In this instance the amount of calcium oxide desiccant used was only 14% of the weight of the dehydrated potatoes as compared to 21% in the experiment

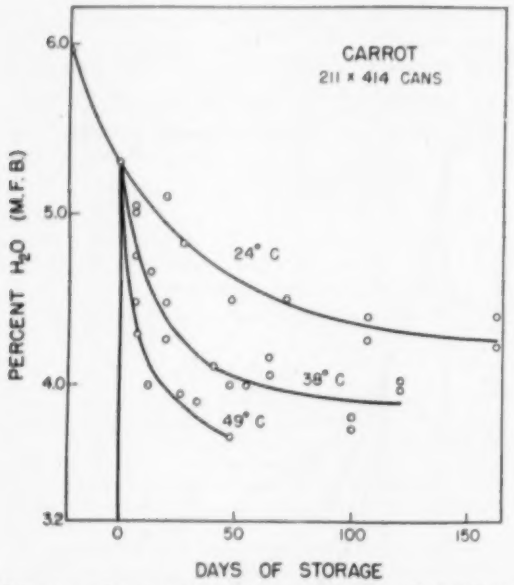

Figure 3. Course of in-package desiccation of dehydrated carrot (⅜" x ⅜" x ⅜" before dehydration) in 211 x 414 cans (4⅞-inch height).

represented in Figure 1; also the 5-gallon cans were opened several times and the contents mixed for sampling; hence comparison of Figures 1 and 4 will be approximate only. Comparison does show, however, that desiccation was much slower in the 5-gallon cans. Recent results show that this disparity in rates of desiccation could be greatly reduced by placing the desiccant at the center of the 5-gallon cans, or by placing the same amount of desiccant, divided into *2* packets, at the one-quarter and three-quarter points within the cans.

TABLE 1

Effect of temperature on rate of in-package desiccation of dehydrated vegetables in cans of 4¾-inch height

Vegetable	Storage temperature	Change in moisture content	Time required for given moisture change	Approximate effect of 10° C. (18° F.) temperature change [1]
	° C.	*%, MFB*	*Days*	
Cabbage	24		160	
	38	2.6-1.2	48	2.3
	49		17	
White Potato	24		140	
	38	5.0-2.4	48	2.1
	49		20	
Sweet Potato	24		165	
	38	5.7-3.2	30	2.2
	49		21	
Carrot	24		120	
	38	5.3-4.3	23	2.8
	49		8	
Beet	24		140	
	38	5.8-4.8	20	3.2
	49		6	

[1] Calculated as the number of days for the given moisture change at 39° C. divided by the number of days for the same moisture change at 49° C., using data from plots of the logarithm of the time required vs. the reciprocal of the absolute temperature.

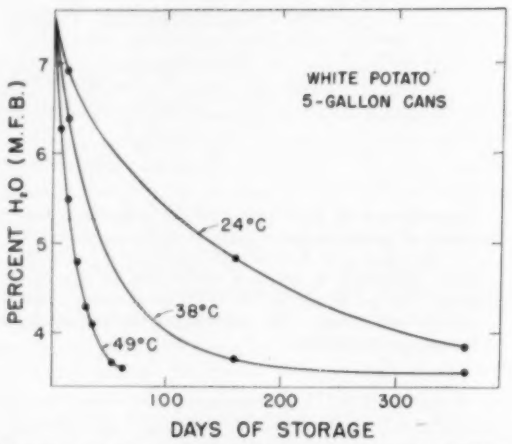

Figure 4. Course of in-package desiccation of dehydrated white potato (⅜" x ⅜" x 5/16" before dehydration) in 5-gallon cans (13¾-inch height), with the desiccant at the bottom of the cans.

DISCUSSION

Substantial protection against nonenzymatic browning is afforded dehydrated vegetables by in-package desiccation even when they are placed at elevated temperature immediately after packaging, particularly if the packaging conditions favor rapid desiccation. However, the rate of browning was found to increase approximately 5- to 8-fold per 18° F. (10° C.) of temperature increase *(1, 2)*, while (as reported above) the rate of desiccation is increased only about 2- to 3-fold by this temperature rise. Hence best protection against browning will be obtained if the product is protected against excessive temperatures until a substantial part of the desiccation has occurred.

Comparison of the temperature coefficients of browning and of desiccation might at first seem to indicate that for the period immediately following packaging the product would most favorably be held at the lowest possible temperature. However, the lower the temperature, the longer will be the time required to achieve a given degree of desiccation. For most products a wide range of initial storage temperatures will be suitable, but from the standpoint of minimizing the time required for a given degree of desiccation a practical "optimum" temperature will exist. This will be the highest temperature at which the desired degree of desiccation can be reached without significant browning or other deteriorative change. This optimum temperature will in most cases be in the neighborhood of ordinary room temperature or a little higher, but it will vary with product and with the type of packaging. It will be increased if conditions require adjustment for more rapid desiccation.

It should be stated that the temperature coefficients of desiccation reported here are for dehydrated vegetables in piece form and in the moisture ranges of importance for the commodities studied; it is possible that substantially different temperature coefficients would be obtained for the desiccation of other products, e.g., orange juice powder, for which lower final moisture levels must be reached.

Inspection of the curves in Figures 1 to 4 shows that the rate of desiccation decreases with decreasing moisture content. A forthcoming paper pertains to the rate of desiccation as a function of moisture content and other factors.

SUMMARY AND CONCLUSIONS

The rates of in-package desiccation of white potato, sweet potato, cabbage, carrot, and beet increase approximately 2- to 3-fold per 18° F. (10° C.) of temperature increase.

Desiccation of carrot was much slower than that of the other dehydrated vegetables studied.

The container size has a marked effect on rate of desiccation for those instances in which the desiccant is located at one end of the container. However, the rate of desiccation in large containers (e.g., 5-gallon cans) can be greatly increased if the desiccant is placed at the centers of the containers, or if the same amount of desiccant, divided into 2 packets, is placed at the one-quarter and three-quarter points within the cans.

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Some Fundamentals of Radiation Sterilization

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Research activities during the last 12 years have aroused considerable interest in the possibilities of food sterilization by ionizing irradiation. This extensive research has been prompted, to a great extent, by the several advantages which this type of sterilization would offer to food processors over heat sterilization. Any damage or destruction caused by heating the product would be eliminated in radiation sterilization, as the dosage necessary for complete sterilization of a product produces a temperature rise usually not over 10° F. *(8)*. An advantage also might be realized in the packaging of a product. Packages used in heat sterilization must be able to withstand high temperatures and pressures. Those suitable for use with radiation sterilization might be much simpler, as their main purpose would be to maintain the sterility of the processed material. The radiation sterilization of food could operate on a continuous production-line basis, which is always more desirable than batch processes. The space requirements and the labor requirements might be considerably less than those necessary with heat sterilization, and general estimates based on laboratory experiments have indicated that the cost of the radiation sterilization might compare favorably with that of heat sterilization for specific products *(8, 16, 22)*.

Coupled with these advantages are certain problems which have become very apparent in the studies of foods subjected to sterilizing irradiation. One of these problems concerns the chemical changes which may be produced in the food by ionizing radiation. Certain so-called side effects can occur as a result of irradiation which cause changes in the flavor, color, and sometimes the texture of the food. Other problems concern the packaging of the foods, the storage life of food products treated by irradiation, and the possible toxicity of cold-sterilized products.

The problems we must recognize in the sterilization of foods with irradiation are not unique to any specific type of irradiation. There is a great similarity in the ionzing effects of X-rays, electrons, and radiations from radioactive substances. Various types of ionizing irradiation have been considered over the years as suitable for sterilizing materials; however, more recent research has been concentrated on 3 types of irradiation; X-rays, high-voltage electrons or cathode rays, and radiation from fission waste products made up of alpha, beta, and gamma rays.

X-RAYS

X-rays are produced by the electron bombardment of a target material, and the quantity of X-rays depends on the electron energy, beam intensity, and atomic characteristics of the target. X-rays are essentially the same as the gamma rays from fission waste products, except that they are machine-produced. X-rays have relatively great penetrating power when the electron energy or accelerating voltage is high. As the accelerating voltage is reduced, the penetrating power of the X-rays is reduced and more of the X-rays are absorbed in the irradiated material. Many possibilities have been suggested for the use of soft X-rays *(16, 18, 19, 20, 23)*. Soft X-rays might be defined as those which comprise the bulk of the radiation emitted from an X-ray tube having a low attenuation window, such as beryllium. Soft X-rays are readily and efficiently absorbed by materials because their penetrating power is a matter of only a few millimeters. When greater penetration is required by food materials, units operating at a high kilovoltage may be used, or two X-ray units may be operated, one above and one below the food material, which would double the depth of material that can be effectively treated. Although the depth of penetration or absorption in materials can be controlled by the design of X-ray units, the over-all depth of treatment is limited by the high absorption of soft X-rays. The efficiency of converting primary electron energy into X-rays is relatively low in the aver-

age X-ray apparatus.[a] X-ray engineers and designers feel, however, that this disadvantage is offset by very definite advantages *(18)*. As soft X-ray equipment operates at low voltages, it is relatively low in cost, which reduces capital investment and makes expensive protective equipment unnecessary. The apparatus could be designed to be nearly automatic in commercial operation, thus requiring no trained X-ray operator. Advocates of soft X-ray sterilization also believe that a multiplicity of tubes would be an advantage on a production line because of the versatility it would provide.

CATHODE RAYS

Cathode rays or high-voltage electrons are artificially accelerated electrons or beta particles. The penetration of high-voltage electrons also depends on the energy at which the electrons are produced. However, their penetration into matter is less than that of X-rays of corresponding voltage. The efficiency of producing high-voltage electrons is considerably greater than that of producing high-voltage X-rays. The equipment necessary to produce high-voltage electrons and high-voltage X-rays is expensive, somewhat more so than that necessary to produce low-voltage X-rays. The electron-irradiation equipment utilizes one tube or a single generator, and requires elaborate facilities for inclusion in a production set-up. During recent years, 2 such electron-sterilization units have been devised and have been tried out on a large scale. One of these is the Van de Graaff generator, which is built by the High Voltage Engineering Corporation in Cambridge, Massachusetts. The Electronized Chemicals Corporation of Brooklyn, New York, has been working for several years on adapting the Capacitron for use in the sterilization of foods. In recent years, intensive research also has been conducted at the General Electric X-ray Corporation laboratories, Milwaukee, Wisconsin, on the development and evaluation of high-voltage electron-bombardment apparatus.

ATOMIC-FISSION PRODUCTS

A third type of radiation which has been considered for food sterilization is that given off by fission waste products. The materials known as fission products are radioactive isotopes that result from the splitting of uranium-235 by neutron absorption. These fission products are unstable as compared with ordinary isotopes, and release energy by radioactive decay. Substantial quantities of these radioactive fission products have been produced by the Atomic Energy Commission as by-products in the operation of nuclear reactors or atomic piles. This material, in considerable volume, has been stored in underground tanks, since disposal constitutes a serious problem. Recently, a coordinated research program has been initiated by the Atomic Energy Commission which includes a study of this waste product for peacetime uses in the food industry *(7)*. Work is being conducted at Columbia University on the possibilities of sterilizing milk. Special attention is being given to feeding studies to determine whether any toxic substance is produced by irradiation of milk with cobalt-60. Studies are also being conducted with cobalt-60 on food sterilization at the University of Michigan, General Electric Company, Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, and the University of Chicago.

These ionizing radiations from fission waste products consist of alpha, beta, and gamma rays, of which probably only the gamma rays would be of importance in radiation sterilization. Alpha rays are actually helium nuclei, and have practically no ability to penetrate liquids or solids. The beta rays are high-energy electrons produced during the disintegration of an unstable nucleus, and these have only moderate powers of penetration. The gamma rays which are produced are, for all practical considerations, the same as X-rays and have great penetrating power.

Large-volume experiments on the use of fission waste products for sterilization have not been under way a sufficiently long time to evaluate them completely. Some theoretical work has been done on investigating these materials for food sterilization. Dr. Bernard Manowitz of the Brookhaven National Laboratory has made detailed calculations on the quantity of fission waste products which would be necessary for a commercial installation. It is estimated that large quantities of these products would be needed for commercial processing. Dr. F. Fahnoe of the Vitro Corporation of America has reported from the research which he supervised that an 8.3 megacurie source would be necessary to sterilize 5,580 pounds of canned meat per hour and a 3 to 3.7 megacurie source for 870 pounds per hour of a liquid with a specific gravity of 1.0 *(5)*. Some attention has been given to the design of a suitable production unit for handling fission waste products. It would necessitate a large installation, and the capital investment would undoubtedly be great. If sizable quantities of fission waste products are made available at a low cost, this ionization material might compete favorably with other radiation methods requiring less capital investment. At the present time, however, it appears that very large quantities of fission waste products may not be available for use within the next 7 to 10 years.

Of the 3 methods of sterilization which have potentialities in the food-processing field, only two have been studied in great detail from the standpoint of production. It is possible that neither of these methods will be the best for all types of food produced. It is more probable that either may be tailor-made to do a specific job better than the other.

Regardless of the type of ionizing radiation which might be used to sterilize foods, there are certain problems concerning cold sterilization with which food processors should be familiar. These problems are significant in the use of either high-voltage X-rays, low-voltage X-rays, or high-voltage electrons, and will undoubtedly be encountered when further work has been done with fission waste products. The degree to which they may occur may vary with the type of radiation used, for, in certain cases, the effects are not so pronounced with one type of radiation as with another. In general, however, these problems must be recognized as potential ones whenever irradiation sterilization is considered for food processing.

When ionizing radiations are used to sterilize foods, side effects are often produced that cause changes in the flavor, color, and odor of the food. The taste changes are usually described by taste-panel members as being oxidative in character, and it was thought at first that these changes resulted from the action of hydrogen peroxide formed in the water during irradiation. Dr. Bernard E. Proctor and others working in the Department of Food Technology at the Massachusetts Institute of Technology, however, have shown that off flavors produced by cathode-ray-sterilized materials were probably due to free radicals produced by the effect of ionizing radiations on water *(15)*. These free ions, which may be strong oxidizing or reducing agents, react with any number of the components of the food being sterilized *(1, 2, 10)*. This may result in an oxidized flavor or in simply a flavor change by modification of certain constituents of the food. Two methods of inhibiting the off-flavor development of irradiated materials have proven satisfactory in some foods. Simple freezing and irradiation of the food in the frozen state can minimize the off flavor developed in certain foods by lowering the diffusion rate of the free radicals produced by the ionizing radiation *(14)*. Other research, using cathode rays, has shown that chemical compounds could be added to serve as free-radical acceptors. One of these substances which has proved fairly effective is ascorbic acid, as well as some of its derivatives *(14)*. This biochemical approach to the prevention of undesirable side reactions may be the more practical one if the chemicals which serve as the best radical acceptors are those which have been cleared by the Pure Food and Drug Administration as suitable for food additives.

The degree of off-flavor produced in foods increases generally as the dosage of ionizing radiations is increased. In many foods, the off-flavor development is definitely noticeable at dosages far below those necessary to sterilize the food. Undesirable flavor changes have been noted in whole milk at dosages of 100,000 rep[b] *(13)*, using supervoltage cathode rays. This is a dosage of

[a] The efficiency of conversion of electron energy to X-ray energy is given approximately by $E = 5.75 \cdot 10^{-3} Vp$, where Vp is the electron energy in peak kilovolts.

[b] rep = Roentgen-equivalent-physical, the unit of cathode-ray dosage corresponding to the Roentgen unit of X-ray dosage.

about one-tenth that which might be required for sterilization. It can be expected, however, that some foods, because of their chemical composition, may be able to withstand a complete sterilization dosage with little or no off-flavor development. The flavor of apple juice is not changed significantly by dosages of one million Roentgen units using soft X-rays or by similar dosages of cathode rays. A blanching of the apple juice was evident, however, after treatment with cathode rays *(12)*. This color change was not evident when soft X-rays were used.

As each food possesses its own chemical individuality, so may the reactions of each be somewhat different to ionizing radiation. This is a significant problem to the food processor, since each product will require individual evaluation. If the food is oxidized to any degree, a color change usually accompanies the oxidation, as well as a change in the odor of the food. It is possible that the biochemical approach may be equally as suitable for prohibiting the development of off colors and odors as for prohibiting the development of off tastes. Certain changes in flavor and color are desirable in processed food, as in the case of canned versus fresh-cooked asparagus. Ionizing radiation in some cases might thus improve acceptability of food products. Although this is considered by some to be doubtful, tests conducted at Battelle Memorial Institute have shown that the flavor of certain alcoholic beverages can be improved markedly by irradiation with soft X-rays.

IRRADIATED FOODS AND STORAGE

Another problem in irradiated foods, somewhat related to the development of off flavors, is the effect on the storage life of the product. The storage life of foods sterilized by irradiation might be markedly different from that of foods sterilized by heat. Research on the sterilization of powdered-milk products conducted at Battelle Memorial Institute by Dr. R. C. McMaster and M. D. Phillips showed that significant off flavors such as rancidity did not develop in powdered-milk products which had been sterilized by radiation until after approximately three-months' storage period. The off flavor was very marked at the end of 6 months. Although off-flavor development in this specific product was known to occur sometimes after storage periods of 5 or 6 months, the reduction of even one month in the optimum storage period of a food would be of definite significance to the processor.

As the side effects of irradiation may not occur in a food immediately after processing, but may develop over a storage time of several months, it would be necessary for the food manufacturer to identify these new chemicals which are produced in the food or conduct animal-feeding trials with the treated foods. To be completely safe, it would be necessary for the food processors to be able to extract these materials, determine the amount present, and be certain that none of them have any toxic properties. Toxicity trials are being conducted on various pharmaceuticals which have been sterilized with ionizing irradiation. The results of these trials are showing, in general, that no toxic materials are produced by X-rays or high-voltage electrons on specific substances. It may be necessary, however, for food manufacturers to verify this fact with their food product, as the pharmaceutical manufacturers are now doing with theirs.

EFFECT ON ENZYMES

Research has shown that it is possible to kill the microorganisms which cause food spoilage by either soft X-rays or cathode rays. An additional factor which must be considered in food spoilage, however, is the action of enzymes. These complex organic compounds catalyze chemical transformations of the foods, which result in changes in taste, appearance, odor, and texture. The effect of ionizing irradiation on enzymes has not been studied as extensively as has been its effect on bacteria and other food-spoiling organisms. Research has shown, however, that a great deal more energy is necessary to inactivate enzymes completely than for the destruction of food-spoiling organisms. Work done by Scott *(21)* using X-rays, and by Dale *(3)* using hard X-rays, by Tytell and Kersten *(24)* using soft X-rays, and by Dunn, Campbell, Fram, and Hutchins *(4)* using cathode rays indicated that a large quantity of energy, possibly ten times as great as that necessary for sterilization, was required to inactivate enzymes in food materials.

It has been found that milk which can be sterilized with about 750,000 rep still shows the presence of enzymes after irradiation with 10 million rep using cathode rays *(12)*. The enzymes in slices of potatoes showed positive tests for peroxidase and catalase even after the application of 8 million Roentgen units with high-voltage X-rays *(1)*, and 4 million Roentgen units of soft X-rays inactivates only about 40% of the catalase in fresh green peas *(17)*. All of these dosages are well above those usually required for sterilization of the product. They are probably much too high to be considered from an economic standpoint, and sufficiently high to cause marked side effects in the product being irradiated. This was illustrated by research done on orange juice using cathode rays. The inactivation of the enzyme in the juice was accomplished, but the loss of aroma and fruity flavor was very great.

The radiation resistance of enzymes increases with their increasing concentration *(3, 6)*; and when enzymes are in their natural environment, many compounds can protect them by competing for free radicals in solution. The radiation resistance of specific enzymes in various foods is not always the same, and definitely can be influenced by the amount of moisture present. Dry, crystalline enzymes are very radiation resistant *(11)*. It is possible that a partial inactivation of some enzymes in certain foods might be accomplished economically at moderate dosages, possibly only twice that required for sterilization. Studies would have to be made to determine the advantages of this partial inactivation in the preservation of the food products.

As enzymes can be readily de-activated by a rapid heat treatment at relatively low temperatures, it is possible that a blanching process might be combined with the irradiation treatment *(14)*. Perhaps electronic heating, such as dielectric heating, might be used with sterilization by cathode rays or X-rays to provide a complete treatment of the food.

RADIATION AND PACKAGING

The packaging of foods becomes a problem when sterilization either by cathode rays or X-rays is considered. Although both of these radiations are able to penetrate most substances, the amount of penetration is an inversely proportional function of atomic density of

the food container. Food containers for use in cold sterilization should be made of low-density materials and be as thin as possible. The cost of sterilizing a material packaged in steel, which is very opaque to these radiations, would be considerably greater than the cost of sterilizing the same quantity of food in an aluminum container, which more readily transmits X-rays or electrons.

Glass greatly attenuates X-rays, and unless the glass container be very thin or the product to be sterilized very expensive, the economic advantage of X-ray sterilization of materials packaged in glass is doubtful. Foods packaged in plastic film are ideal for radiation sterilization, because plastics absorb very little of the energy passing through. To maintain sterility and prevent dehydration and gas transmission, it might be necessary to laminate two or more of the plastics into a uniform packaging film. Vacuum packaging has been suggested for use with radiation sterilization, as well as packaging in an atmosphere of an inert gas. If oxygen were not present in a sealed container of food, the side effects produced by irradiation might be reduced markedly. The sterilization dosage might be increased, however, under these conditions, as some data have shown that bacteria are more radio-sensitive in the presence of oxygen *(9)*.

The size of the package to be sterilized must be considered in X-ray or cathode-ray sterilization. An optimum-size package might be a flat container, 1 inch thick by 4 inches square. The optimum package size must be determined, however, for every material to be sterilized. It would depend upon the quantity of radiation absorbed by the container material, the degree to which the food would attenuate the X-ray beam, and the dosage required for sterilization. The manufacturers of packaged materials have been very much interested in cooperating in the cold-sterilization program, even to designing new containers suitable for the processing of foods by this method. This problem, therefore, may not be a limiting factor, but is certainly one which must be considered.

These are not all of the problems which will be confronted in the cold sterilization of foods. Consideration must also be given to costs, and the design of equipment to provide optimum versatility. Other problems still may be encountered in future studies. Most of the scientists who have been engaged in the study of sterilization techniques believe that processing of foods by ionizing radiation without heat will soon be a reality in commercial production. This belief is being backed up by intensive research on these problems, and satisfactory solutions may soon be obtained to many of them. There is little hope that ionization sterilization will ever be an anodyne for all the sterilization headaches of food processing. If products are studied individually, however, and these problems, which vary with each material, are answered for specific types of foods, it is quite probable that ionization sterilization will soon be commercially significant in food-processing plants.

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Stabilization of Frozen Citrus Concentrates by Heat Treatment

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A series of experiments on stabilizing the cloud in orange juice concentrates was performed to obtain information concerning the effects of different temperature levels of heat treatment (using direct steam injection heating), the effects of concentration on a given heat treatment, and the effects of holding time on different temperature and concentration levels. The results indicate that direct steam injection can be used to effect a wide range of heat treatments which result in increased cloud stability without causing detectable flavor damage as determined by triangular taste tests. There appears to be a significant effect upon the resulting cloud stability depending upon the combination of concentration and temperature of the heat treatment. The degree of cloud stabilization showed a general but not quantitative agreement with the amount of pectinesterase inactivated.

In the manufacture of processed citrus juices, heat treatment has been commonly employed to prevent cloud loss in the resulting products *(1, 6, 9, 11, 12, 13, 15, 26)*. The causative agent has been generally thought to be the pectic enzyme, pectinesterase (PE), and the inactivation of this enzyme in citrus juice by heat treatment has been extensively studied and reported *(2, 3, 4, 5, 17, 19, 21, 25, 27, 28, 29, 31, 32)*. A suitable heat treatment of sufficient duration and temperature can be employed to completely inactivate this pectic enzyme, and such treatment will generally result in a product with excellent cloud stability. Such a treatment, particularly in orange juice, may cause marked undesirable off-flavors or "cooked" flavors. However, in the case of frozen citrus concentrates, complete inactivation of PE may not be necessary to obtain sufficient cloud stability in the product to accommodate the abnormal temperatures anticipated in the storage life of the product.

The process used in the manufacture of frozen concentrates presents several unique conditions for the application of heat treatment. The evaporation process offers different concentration levels at which heat treatment may be applied satisfactorily. Also, the application of unique heating systems may be employed, such as direct steam injection, which is particularly suited to high vacuum condensation systems of low temperature evaporators.

The purpose of this work was to gain fundamental information on the role of heat treatment in effecting increased cloud stability in frozen concentrated citrus juices.

EXPERIMENTAL

Design of experiment. A factorial experimental design was chosen, since it allows all factors to be investigated simultaneously, and at the same time, enables an evaluation of the interactions which may occur between various treatments. The results of such an experiment can be analyzed statistically. The experimental program chosen was such that the three factors—temperature of heat treatment, holding time at each temperature, and juice concentration during heating—were varied in a controlled manner. Three temperatures were used, 150° F., 175° F., and 200° F. (66.0° C., 79.8° C., and 93.0° C.); two holding times, 1 second and 20 seconds; and 4 juice concentrations, 12°, 27°, 43°, and 58° Brix. The treatments were carried out in all combinations of these factors; thus, 24 treatments were performed. They were conducted in random order to obviate any unforeseen systematic circumstances occurring during any particular set of runs.

Direct steam injection was used in these experiments because of its characteristic advantages of instantaneous heating without hot surfaces and localized overheating, and the ease with which a holding time at any temperature can be accurately estimated. Heating by direct injection of steam into a product, of course, causes the material to be diluted by condensation of the steam. Therefore, the concentration of the juice as reported in this study was that fed to the injection heater and not that existing in the injection chamber. The approximate corrected juice concentrations existing during heating were 11°, 25°, 40° and 54° Brix.

To eliminate variations introduced by using different juices, a uniform batch of frozen 58° Brix concentrate was used. The required portion for each treatment was diluted to the proper concentration, subjected to the respective heat treatment and reconcentrated to 58° Brix as shown in Figure 1. In the case of the 58° Brix concentration there was no dilution or reconcentration required. In order to determine if the dilution and reconcentration steps themselves caused any degradation of the cloud or decrease in cloud stability of the resulting concentrate, a control sample was prepared for each heat treatment in a similar manner excepting that the juice was not heated; thus 24 control lots were prepared. These controls were usually prepared immediately following the respective heat treatments so as to provide a further check on the particular juice and equip-

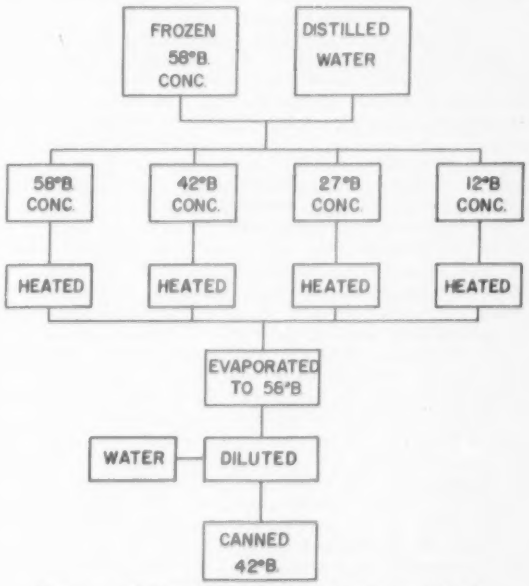

Figure 1. Schematic of heat treatment procedure.

[a] Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture. Presented at the Annual Meeting of the Institute of Food Technologists, Boston, Mass., June, 1953.

ment during that treatment. Some of the original concentrate was held as a master control.

The concentration at which orange juice is most labile to cloud damage at elevated temperatures has been established by Cotton, *et al. (8)*, Rouse *(25)*, and Rice, *et al. (22)* to be approximately 42° Brix. Since the major point of this investigation was to study the effect of a particular heat treatment on cloud stability, the final products were prepared by diluting the 58° Brix concentrate to 42° Brix with distilled water for subsequent tests of cloud stability.

Material. The frozen California Valencia orange concentrate used as the material for this study was commercially prepared. The fruit was extracted by a Brown[b] citrus extractor, finished in a paddle finisher with .020-inch openings, and concentrated in a single effect, three stage, low temperature falling film evaporator at approximately 55° F. (12.8° C.). A 400-gallon batch of concentrate was thoroughly mixed and 70 gallons was withdrawn, filled into 5-gallon enamel lined cans, frozen, and stored at 0° F. (—17.8° C.) for approximately one week before treatment. A 12° Brix juice prepared from the concentrate had a brix-acid ratio of 11.2 to 1, a recoverable oil content of 0.003% (v/v)[c], a pulp content of 6% (v/v)[d], and pH 3.5.

Equipment. Heating was done using an experimental size direct steam injection unit similar to that described by Brown, *et al. (7)*. The short holding time injection heater was constructed of ½-inch i.p.s. stainless steel pipe with an outlet orifice 4⅝ inches downstream from the steam inlet. The longer holding time was achieved by the addition of a 38-inch length of 1-inch O. D. stainless steel sanitary tubing between the orifice and the 4⅝-inch long unit. A copper-constantan thermocouple was located at the end of the shorter injection heater section for both conditions and connected to a high-speed electronic indicating potentiometer. The bare junction was immersed in the fluid stream. The thermocouples were calibrated using a National Bureau of Standards certified thermometer. The injection heater was connected directly to a low temperature falling film evaporator described elsewhere *(23)*. A positive displacement pump with variable speed drive pumped the feed juice through the injection heater to the evaporator as described in Figure 2. Saturated steam was supplied to the injection heater from a boiler pressure of approximately 100 p.s.i.g. No special treatment was given the steam which was obtained from a small packaged boiler using zeolite softened water without any boiler compounds added. Samples of the steam were condensed and carefully checked to make certain no flavor would be imparted to the heated product from the steam.

Heat treatment. For each heat treatment approximately 1½ gallons of concentrate was withdrawn from a container which had been allowed to warm slightly to 10-20° F. (—12.2° C.-—6.67° C.) and which had been thoroughly mixed to insure homogeneity of the contents. When necessary, the concentrate was diluted with distilled water to the required concentration within ±1° Brix. With the evaporator under a pressure of 10-15 mm. Hg. absolute, orange juice was pumped through the injection heater into the evaporator and discarded until the temperature was adjusted and the flow rate calibrated to allow for dilution occurring during treatment. When the system was stabilized, the sample was retained in the evaporator. The heating temperature was controlled manually to within ±3° F. (±1.67° C.) of the desired temperature. The product was instantly cooled by flashing from the injection heater into the evaporator at approximately 55° F. After heating, the juice was concentrated to approximately 58° Brix at about 60° F. (15.6° C.) using 95° F. (35.0° C.) hot water as a heating medium. It was withdrawn from the evaporator, diluted to 42° Brix, ±1° Brix, with distilled water, canned in 6-oz. citrus enameled containers, and frozen. A similar procedure was followed for each control batch excepting it was not heated. The equipment was thoroughly rinsed between samples to avoid contamination.

Analyses. The resulting products were tested for the effect of heat treatments upon the flavor, cloud stability and PE content.

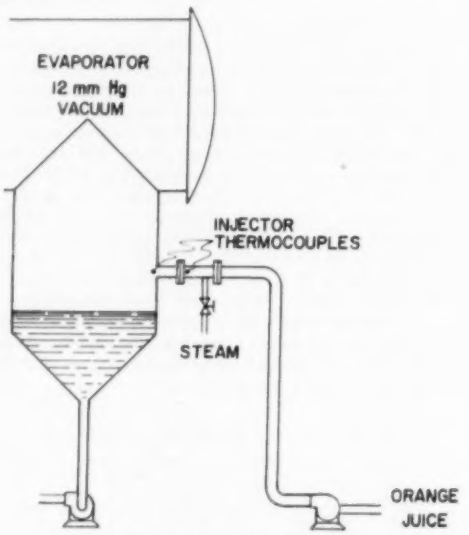

Figure 2. Schematic of apparatus.

The effect on flavor was determined by comparing the treated sample to its respective control by the triangular taste testing technique *(20)*. A taste panel of approximately 10-15 laboratory workers was employed, obtaining 18 judgments for each test by duplicating individual judgments as required. This analysis determined the effect of the heat treatment only since the control and treated samples were subjected to the same procedure during preparation.

The effect upon cloud stability was determined by storing the 42° Brix products at 40° F. (4.44° C.) and measuring the cloud at frequent intervals by a method similar to that described by Loeffler *(16)*. A 25-g. sample of concentrate was diluted with 75 g. of water and allowed to stand in a water bath at 86.0° F. (30° C.) for one hour. The juice was then centrifuged[e] for 15 minutes at 2,000 r.p.m. and the transmission of the supernatant measured in a Klett colorimeter using a No. 66 red filter. The light transmission value as measured was termed the *cloud value*.

The PE activity of the experimental samples was determined by the method of McColloch and Kertesz *(18)*, with minor modifications. An orange concentrate "blank" was prepared for the determinations from some of the initial commercial concentrate. This concentrate was heated for 15 minutes at 210° F. (99.0° C.) to inactivate enzymes. It was then cooled to room temperature, adjusted to 42° Brix with distilled water, neutralized to pH 7.00 with 0.5 *N* NaOH, and frozen for later use.

Preliminary PE determinations were made on the experimental samples to estimate the level of activity to be expected. This information was employed to select aliquots of the more active samples such that not more than 50% of the available ester bonds would be hydrolyzed during the course of the determination, thus insuring a constant reaction rate.

Final determinations were carried out in 100 ml. of 0.5% Pectinum, (N. F. VII), containing 0.1 *M*. NaCl at pH 7.00 and 30° C. using an automatic titrator. The predetermined aliquot of the experimental sample plus sufficient "blank" concentrate to make a total volume of 10 ml. of concentrate in the reaction mixture was added to the substrate. With instrument control set to read only pH, the reaction mixture was adjusted to pH 7.10 to 7.30 by adding 0.5 *N* NaOH. The instrument controls were then set at pH 7.00 and the anticipation control set at 5.

[b] The mention of special instruments throughout this paper does not imply that they are endorsed or recommended by the Department of Agriculture over others of a similar nature not mentioned.

[c] By Cleveneger method.

[d] By centrifuging in an International Clinical Centrifuge using a No. 211 regular head and 15 ml. graduated, cone point tubes.

[e] See footnote *d*, except used 50 ml. round bottom tubes.

As the pH drifted below 7.00 and the first increment of 0.1 *N* base was added by the instrument the burette was read and a timer started. The reaction was allowed to proceed for 30 minutes, burette readings being checked at intervals to determine that the reaction rate was constant.

Duplicate PE determinations were made on each experimental sample and averaged. The PE units per ml. of sample (PEu/ml.) *(14)*, were then calculated.

RESULTS AND DISCUSSION

Flavor. The effect of heat treatment upon the flavor of reconstituted juices made from these products is shown in Figure 3. It will be noted that only a flavor

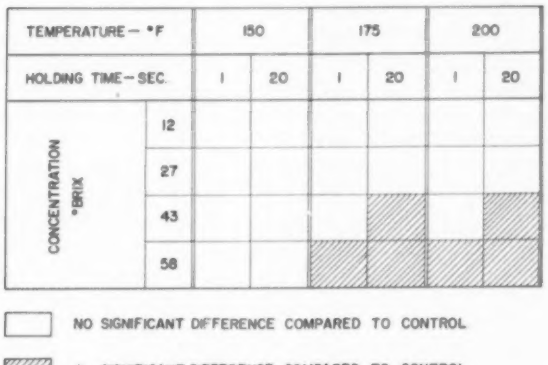

Figure 3. Effect of heat treatment on flavor of orange juice concentrate.

significantly different from the control was reported, since there is no reasonably simple quantitative method to determine the degree of flavor change in citrus juices. Differences reported as significant were between the statistical 5% and 1% levels as determined by Roessler's *(24)* method of calculating the significance in triangular taste tests. These differences are not great when it is considered that the judges were experienced tasters of citrus products, and only 10 or 12 judges out of 18 could correctly identify the odd sample. It should be noted further that these products were prepared without the addition of cutback juice. Had unheated cutback juice been used, these flavor differences might have been reduced.

From Figure 3, the indications are that as the concentrations increased there was a tendency toward flavor change as a result of heat treatment. This result may have several explanations. More flavor damage will probably occur from heating the concentrated product due to the increased concentration of the reactants causing flavor changes. Also, the higher concentration levels were subjected to correspondingly less evaporation after heating which might be expected to remove less off-flavors developed by heating.

Among other factors that should be considered when evaluating these results is that with steam injection heating, the lack of hot heat exchanger surfaces should materially lower the danger of a burned flavor. Evaporative cooling will not only lower the temperature of the heated product instantly, and thereby lower the overall time the product is at an elevated temperature, but the evaporation process itself may remove any flavor imparted to the product as a result of heating. In addition, the inherent design of the experiment employed a juice which has been previously evaporated. The results may be prejudiced in this respect regardless of the control scheme. It should be noted, however, that the concentrate used to prepare these products had no detectable off-flavor and was of good quality. It is apparent that orange juices of the lower concentration ranges used can be subjected to considerable heating under these conditions without materially affecting the flavor of the resulting product.

Pectinesterase activity. The experimental design utilized for this work provides an opportunity to analyze the PE data for a number of factors. Not only can the effects of the 3 imposed treatments, temperature, holding time, and concentration, upon PE be observed, but also the interactions between these treatments can be determined. Therefore, it can be determined if any special effects resulted from a certain combination of temperature and concentration, or temperature and holding time, or concentration and holding time which would not have been predictable from simply combining the results obtained from each treatment separately. A statistical, or variance, analysis of the results was performed to determine if the effects attributable to the treatments were really significant or if there was insufficient evidence in the data to draw such conclusions. The interaction between temperature, holding time, and concentration was used as a variance error estimate *(30)*.

Inspection of the results shown in Table 1 and Figures 4 and 5 indicates the following: There is a marked effect of temperature on the retention of PE during heating; the effect of holding time on the retention of PE is very pronounced; and the concentration at which the juice was heated has an effect on the inactivation of PE. Statistically, these 3 effects were

TABLE 1

The effect of heat treatment on pectinesterase and cloud stability

Treatment conditions			Results	
Temperature °F.	Hold time seconds	Concentration °Brix	% of initial PEu [1]	% of control cloud loss rate
150	1	12	61	98
150	1	27	45	41
150	1	43	45	29
150	1	58	50	33
150	20	12	39	36
150	20	27	17	5
150	20	43	5	7
150	20	58	33	13
175	1	12	17	12
175	1	27	3	5
175	1	43	9	3
175	1	58	7	1
175	20	12	5	40
175	20	27	9	10
175	20	43	9	2
175	20	58	9	2
200	1	12	3	0
200	1	27	1	0
200	1	43	1	0
200	1	58	2	0
200	20	12	1	0
200	20	27	2	0
200	20	43	0	0
200	20	58	0	0

[1] 100% = 60 PEu/ml. x 10^{-4}.

found to be highly significant. The results obtained due to the temperature of heat treatment and holding time are to be expected in view of previous investigations *(3, 11, 21, 26)*. It is not clear-cut from the results that heating at a particular concentration will cause a greater inactivation of PE than any other, excepting that heating any of the higher concentrations brings about a greater inactivation of PE than in single strength juice.

Closer inspection of the data indicates a pronounced relationship between the temperature of the heat treatment and the holding time on the inactivation of PE. This relationship can be shown to be highly significant. This indicates that far less holding time is required to achieve a given degree of inactivation at the upper temperature than at the lower, as is also to be expected in view of previously reported investigations *(3, 11, 21, 26)*.

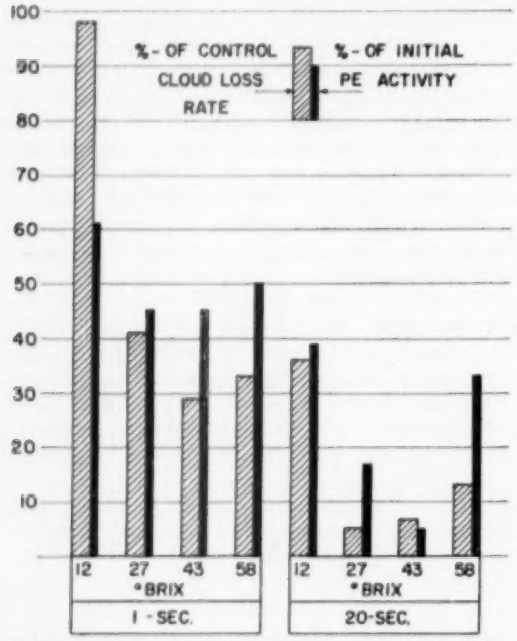

Figure 4. Effect of 150° F. treatment on cloud stability and pectinesterase activity.

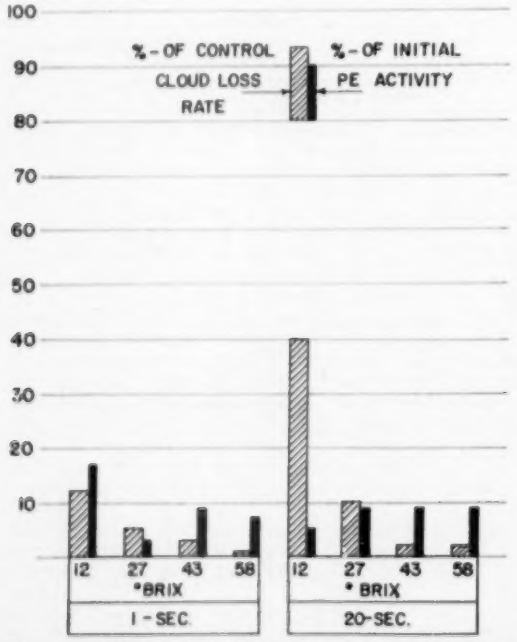

Figure 5. Effect of 175° F. treatment on cloud stability and pectinesterase activity.

There appears to be a barely significant interaction between concentration and holding time. That is, the statistical odds are about 20 to 1 that there is a certain combination of concentration and holding time which brings about a greater inactivation of PE than at any of the others. It is difficult to discern which particular concentration exerts this effect, but it appears that the holding of single strength juice generally results in a greater percentage of inactivation of PE than holding the higher concentrations.

The results indicate there is a marked effect on the retention of PE obtained by certain combinations of temperature of heat treatment and concentration of the juice. Statistically, this interaction is highly significant. By careful inspection of the data, it appears that the effect of concentration on PE inactivation is more pronounced at 150° F. than at 175° F., and more at 175° F. than at 200° F.

Cloud stability. The effect of the respective heat treatments on the cloud stability of the products is shown in Figures 4 and 5 and Table 1. The analyses were not continued beyond 60 days because by this time mold and microorganism growth would have made the results questionable. Cloud loss is fundamentally a rate process which in simple cases can be expressed as a half-life. However, in more complicated cases it can best be expressed by determining the slope of the line obtained by plotting cloud value against time in days. The half-life of many of the treated samples was so great that the values were unreliable when compared to short half-lives. Further, the data showed scattering, even in the samples with the shorter cloud lives. Therefore, it was necessary to obtain the slope of the best cloud loss curves. The periodic cloud values for each sample were plotted graphically by days and the best straight line drawn through these points. The slope of this straight line was taken as the rate of cloud loss. Similarly, the rate of cloud loss was obtained for the controls. The average of all the controls was used, since there were no significant differences in cloud stability between any of them. The cloud stability values given represent those obtained by taking the ratio of the slope of the treated sample to that of the slope of the control expressed as a percentage. This, therefore, represents the rate of change of cloud of the treated samples as compared to the rate of change of the cloud of the controls. The control samples were badly clarified in 2 days when stored at the same conditions. This represents a half-life of one day.

The effects of the various treatments upon the cloud stability were statistically analyzed in a manner similar to that employed for the PE results.

There appears to be a definite concentration effect, that is, the higher concentrations at which the juice was heated apparently resulted in increased cloud stability.

Statistically, the odds are 27 to 1 that this effect was demonstrated by the data. The effect of the temperature of heat treatment upon the resulting cloud stability is similarly shown to be highly significant, and the statistical odds are about 400 to 1 that this effect was demonstrated by the data.

From the results as a whole, the effect on the cloud stability by heating the juices for 20 seconds instead of one second is not clearly demonstrated. The statistical odds are only 9 to 1 that the data demonstrated any effect upon the cloud stability by holding the juice longer. This is not generally considered to be a significant result. However, the combination, or interaction, between holding time and temperature does appear to be significant. This indicates that the effect of holding time is demonstrated at a particular temperature; this temperature is apparently 150° F.

The 175° F. treatments appear to produce several anomalies which are difficult to reconcile with the PE inactivation data, or with that which would be expected from experience, assuming PE is the sole cause of cloud loss. Holding at this temperature for one second produced a stability in all concentrations which is, in general, in satisfactory agreement with experience and the results obtained at 150° F. Nevertheless, a one-second holding at 175° F. on 12° Brix juice did not produce the stability achieved by heating 27° or 43° Brix juice at 150° F. for 20 seconds. The results obtained at 175° F. and 20 seconds are inexplicable with our present knowledge of the cloud loss mechanism. The fact that holding 12° and 27° Brix samples for 20 seconds at 175° F. instead of one second resulted in a product with a lower cloud stability is difficult to explain. These particular treatments were duplicated to determine if these results were erroneous; identical results were obtained.

All of the heat treatments at 200° F. produced concentrates with excellent cloud stability. These products were held 60 days at 40° F. without showing any signs of cloud loss. It would appear from these results that a short holding time at 200° F. produces such cloud stability that for the purposes of frozen concentrate longer holding times are unnecessary at this temperature. The same would appear to be true of the effect of concentration. Although there does appear to be a concentration effect upon the inactivation of PE, utilization of this effect does not appear to be warranted at this temperature unless complete inactivation was desired.

Pectinesterase and cloud stability. Since it was the purpose of this work to gain fundamental information on the mechanism by which heat treatment brings about cloud stability in citrus concentrates, it is important to interpret the results further than merely reporting the cloud rate and PE content after a particular treatment. It is common practice in citrus research to treat PE as the sole cause of cloud loss and to expect a corresponding stability to result from a given reduction in PE. Therefore, it is important that the correlation of the amount of PE to cloud stability be evaluated.

In any one single juice, as employed in this study, if PE is the sole cause of cloud loss, there should be a linear relationship between the two. When PE and cloud loss data of Table 1 are plotted as shown in Figure 6, it appears that a correlation does exist, and a linear correlation coefficient of +.893 was obtained *(10)*. A coefficient of +1.0 indicates perfect proportionality; 0.0 indicates none. Statistically this coefficient is very highly significant. The equation of a straight line which best fits the data is $Y = .79X + 5.2$, where Y is the percent PE remaining after heating and X is the per-

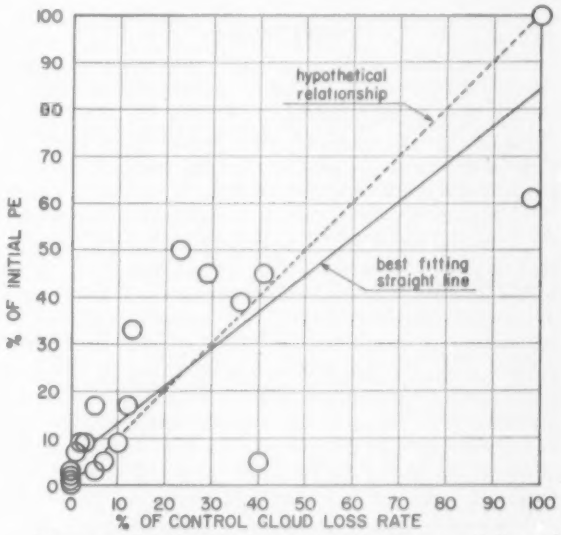

Figure 6. Relationship between pectinesterase activity and cloud loss rate.

cent cloud loss compared to the controls. This line is plotted on Figure 6 and compared to the hypothetical relationship. However, the reliability of any value obtained from this calculated line is 11.5 percentage units, and the 95% confidence range is ±23 percentage units; i.e., if a cloud value were obtained for a PE value from this line, 95% of the time it probably would be only within ±23 percentage units of the true value. This indicates that the data are scattered considerably and the line is not too reliable as an estimate.

Therefore, despite the statistically significant correlation between the amount of PE and rate of cloud loss, and that the calculated best line appears to be in close agreement with the hypothetical line, it is questionable that PE is the sole cause of cloud loss occurring in citrus juices. It is very probable that PE is involved in the cloud loss process, but it is also possible that other independent factors are involved in the *prevention* of cloud loss by heat treatment other than the inactivation of PE. Therefore, a correlation between the amount of PE inactivated and cloud stability does not indicate how important PE is to the cloud loss mechanism, or that PE alone causes cloud loss, or whether PE in combination with other factors such as heating, homogenization, etc., bring about this relationship. It is known only that PE acts upon pectin to bring about changes which could result in cloud loss, but the observation that a correlation exists between the amount of PE remaining after heating with increased cloud stability does not evaluate the role of the causes involved. It simply determined the regularity with which the amount of PE

was in accord with the cloud loss rate based on the supposition that all the factors involved in the cloud mechanism could be lumped together as cloud loss rate vs. PE. Some other relationship may show a much better correlation. Furthermore, in view of the anomalous results at 175° F. for 20 seconds, which were reproducible, further credence can be given to the proposition that cloud loss may be brought about by a more complicated mechanism.

CONCLUSIONS

There appears to be a general relationship between cloud stability and PE activity despite the anomalous results obtained by heating at 175° F. for 20 seconds. However, the results do not indicate that any particular cloud stability can be predicted on the basis of absolute PE activity in processed products.

The effect of concentration during heat treatment on the resulting cloud stability appears to be very significant, particularly at the lower temperature level. This would indicate that if a lower temperature of heat treatment were employed the effect of concentration would be worthy of consideration. This is particularly important when it is recognized that considerably less heat is required to heat approximately one-fourth as much material at 43° Brix along with the fact that less heat is required for the attainment of a lower temperature. A lower temperature offers the further advantage that there is less danger, if any, of a flavor damage occurring.

The results appear to indicate that direct steam injection can be used to effect a wide range of heat treatments in citrus juices without materially altering the flavor of frozen concentrates prepared theretrom.

It should be recognized that these results were obtained from only one lot of frozen orange juice concentrate, and it would be premature to conclude that all citrus juices would respond in a similar manner.

Acknowledgment

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Estimation of Maturity of Frozen Peas. Tenderometer Measurements on Cooked Product

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Use of the tenderometer for measuring texture of cooked frozen peas was investigated. The effects of several procedural variables were studied and a recommended method developed. The test correlated well with organoleptic evaluations of texture and has the advantages of speed and objectivity.

In an earlier study *(10)*, 68 samples of frozen peas were evaluated for texture by a taste panel and were also submitted to a number of chemical and physical tests. One of these, the tenderometer value of the cooked product, was new, and showed promise as a convenient and reliable index of "tenderness and maturity" of peas in the form in which they are consumed. The procedure, its reliability, and its limitations will be described in this paper.

Since peas are toughened by exposure to water containing calcium ions, the effects of distilled water and of calcium chloride solution in cooking and cooling were studied. Other variables were cooking time, amount of cooking water, method of cooling, temperature at which measurements were made, fill of the tenderometer grid cup, and compression of the pea sample in it. A satisfactory procedure for measuring texture in peas with the tenderometer was developed, results of which compare well with the results obtained by a taste panel of trained judges.

EXPERIMENTAL

The peas were grown in Farmington, Utah, in 1949, 1950, and 1951, with the exception of Wyola, which was grown near Half-Moon Bay, California in 1951. The handling and processing of these peas, the methods of organoleptic appraisal of skin and cotyledon texture and analytical methods including determination of alcohol-insoluble solids have been described *(10)*. All peas were blanched 1.5 minutes in steam at 212° F. (100° C.) prior to freezing.

Measurements were carried out with a standard model of the tenderometer (MH-490) with weights WCT-136 and WCT-137 and scale No. 2, normally used for raw peas. The performance of this instrument has been described by Martin *et al. (11)*, Lee *(8)*, and others. Unless otherwise indicated, 200 g. of peas (drained weight), which fill the grid cup without compression, were used for each measurement. The grid was rinsed before and after use. The sample and the rinse water were at 73° F. (23° C.), except where temperature was the experimental variable. The values in the tables and graphs are averages of 5 to 11 replicate determinations. Standard deviations were estimated by the method of Dean and Dixon *(3)*.

Effect of cooking time. The frozen peas were always added directly to boiling water. Cooking times for tenderometer studies as well as organoleptic appraisal were counted in minutes after boiling was resumed.

Experiments on frozen-thawed peas and peas subjected to varying cooking time showed that the tenderometer values dropped rapidly in the first few minutes of cooking (or blanching), but gradually leveled off. Figures 1a and 1b show that with cooking times of 8 to 12 minutes the change in tenderometer values was fairly slow.

Cooling methods. Tenderometer determinations on cooked peas given in the earlier publication *(10)* had been carried out with 8 minutes of cooking followed by dry cooling (placing the pan in ice water). To terminate the cooking process more rapidly and uniformly, direct immersion in cold water of the drained hot peas (wet cooling) was investigated. Under our conditions (at sea level) it was found that the 8 minute cook followed by dry cooling was approximately equivalent to a 10-minute cook followed by wet cooling. The latter method was used in most of the experiments that follow. Where the effect of hard water upon tenderometer readings was studied, the peas were cooled in chilled tap water or calcium chloride solution instead of the usual distilled water.

Effect of hardness of cooking and cooling water. Hard water used in cooking and wet cooling of peas was found to increase the tenderometer readings. Therefore, a study was made on several varieties and maturity levels of peas in which the cook-

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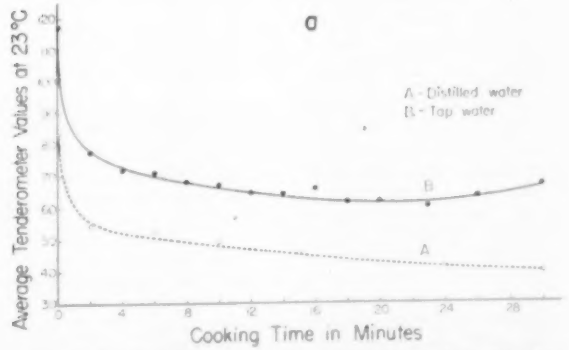
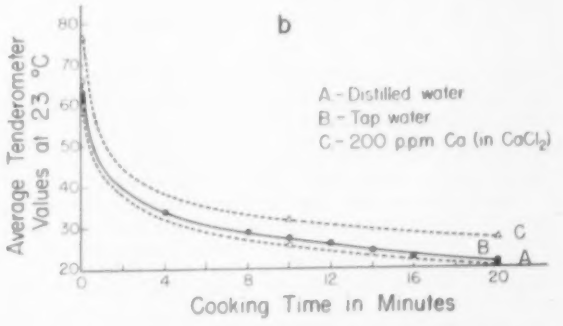


Figure 1. (a) Effect of cooking time and of cooling by immersion in distilled and in tap water. Variety, Thomas Laxton, size group 5 + 6. Tenderometer value of raw peas = 124.2.



(b) Effect of cooking and cooling in distilled water, tap water and calcium chloride solution. Variety, Dark Seeded Perfection, size group 3 + 4. Tenderometer value of raw peas = 94.0.

TABLE 1

Influence of calcium chloride solution on the toughening of peas cooked 10 minutes followed by wet cooling

Variety	Raw peas			Tenderometer measurements at 73° F. (23° C.) Cooked peas				
				Distilled water		$CaCl_2$ soln. (200 p.p.m. Ca^{++})		
	Size	Tend.	S_w[1]	Tend.	S_w[1]	Tend.	S_w[1]	Gain, %
Thomas Laxton	5 + 6	87.7	1.8	19.9	0.8	29.0	1.8	45.7
Thomas Laxton	5 + 6	91.7	1.5	25.8	0.4	33.2[2]	2.8	28.7
Dark Seeded Perfection	3 + 4	94.0	1.9	25.4	1.2	31.6	0.4	24.4
Oracle	5 + 6	107.4	0.9	31.7	0.8	47.1	4.0	48.6
Thomas Laxton	5 + 6	108.2	4.2	40.7	1.8	54.8	2.4	34.6
Dark Seeded Perfection	3 + 4	108.3	4.1	38.7	1.6	47.3[2]	2.0	22.2
Wyola	3 + 4 + 5	120.3	7.3	78.9	2.4	94.8	2.2	20.2
Dark Seeded Perfection	5 + 6	148.2	5.3	64.5	1.8	80.7	1.8	25.1

[1] S_w = Standard deviation estimated by method of Dean and Dixon *(3)*.

[2] Cooked in distilled water, but cooled in calcium chloride solution. All other samples were cooked and cooled in the same solution.

ing and immersion cooling were made in (1) distilled water, (2) dilute calcium chloride solution (200 p.p.m. of Ca^{++}), and (3) tap water. The results of (1) and (2) are summarized in Table 1, while those of (3) were omitted because of variation in hardness of the local tap water. Consistent toughening was observed in peas cooked and wet cooled in local tap water; the increase in tenderometer reading ranged from 6.7 to 17.7%, but was always lower than the increase in toughening of the same peas due to calcium chloride solution (Table 1).

Figure 1 (a) illustrates the effect of immersion cooling in distilled and tap water; Figure 1 (b) shows the effect of cooking and cooling in distilled water, tap water, and dilute calcium chloride solution.

In Table 1, the samples are arranged in the order of increasing tenderometer values of the raw material. This order is not materially changed in the resulting tenderometer values of peas

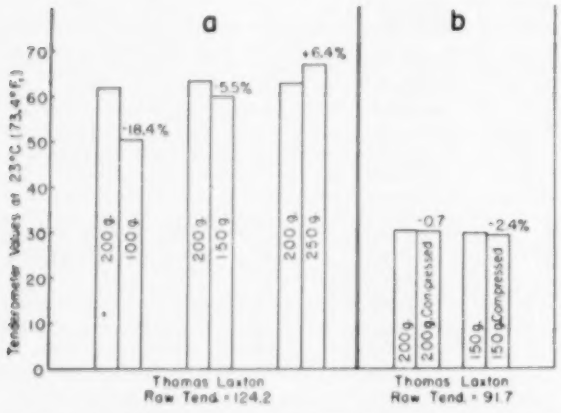


Figure 2. Influence on tenderometer values of (a) weight of peas in grid cup, and (b) compression of sample.

cooked and cooled in distilled water, tap water, or dilute calcium chloride solution, with the exception of the variety Wyola. This sample differed from others in variety, location of growth, processing conditions, and time of delay in the shelled condition (vined in the field, held iced for 2 to 3 hours before blanching). The others were shelled and blanched at once.

Table 1 demonstrates that cooking and cooling (or cooling alone) in dilute calcium chloride solution had a toughening effect. There is some indication that the more tender peas appeared to toughen less than the more mature peas; this difference is not apparent when the toughening is calculated as percentage gain in tenderometer values (last column, Table 1).

Our results showing the toughening of frozen peas cooked and cooled in calcium chloride solution confirm earlier studies on canned peas *(1, 4, 9)*. The concentration of Ca^{++} used in our experiments (200 p.p.m.) is no higher than in the hard waters known to occur in certain localities.[b]

Effect of amount of cooking water. Equal weights of frozen peas and distilled water for cooking were compared with double and half the weight of water. The results (Table 2) show that wide differences in amount of cooking water have little effect upon tenderometer readings when effective cooking time is kept constant. Therefore all measurements were made with amounts

TABLE 2

Effect of amount of cooking water on tenderometer readings of frozen peas. Thomas Laxton, Utah, 1951. Size 5 + 6. Tenderometer of raw peas = 124.2. Cooking time = 8 minutes with dry cooling

Frozen peas lbs.	Distilled cooking water lbs.	Tenderometer at 23° C.		
		No. of determinations	Average value	S_w[1]
2	4	9	60.3	1.0
2	2	10	59.2	2.3
2	1	9	59.2	3.4

[1] S_w = Standard deviation after Dean and Dixon *(3)*.

of cooking water equal to one-half the weight of frozen peas, which provides sufficient water to cook them. Distilled water was used for cooking all samples except where water hardness was an experimental variable.

Effect of weight of peas and method of filling tenderometer grid cup. The manner of filling the grid cup may cause small errors. A normally filled tenderometer grid cup holds approximately 200 grams of cooked, drained peas. With 100 grams, the tenderometer values were 18.4% less and with 150 g., 5.5% less than with the normal 200 g. With 250 g. (compressed) the tenderometer values were 6.4% higher than normal (Figure 2a).

When weights of sample were the same, compression had a negligible effect upon the readings (Figure 2b). The error is greater with more mature peas, though less mature peas will pack into the grid cup more readily. With a little experience, ordinary filling of the grid cup gives good results, as small differences in sample weight from 200 g. fall within the range of expected experimental error.

Effect of temperature. Tenderometer measurements at this Laboratory were made at 73° F. (23° C.) for both raw and

[b] Increased toughness of peas in processing may be partly due to Ca^{++} in the blanching and fluming water and/or to the considerable amount of calcium present in common salt *(1)* used in brine separators (brine flotation). This toughening could probably be remedied by adding sodium hexametaphosphate to the brine *(5, 12)*. The amounts of hexametaphosphate to be added must be determined experimentally under plant conditions. The tenderometer method described in this paper could be used to determine the optimum levels of hexametaphosphate needed, but it must be remembered that peas also toughen with delay before blanching *(2, 13)* and as a result of natural ripening.

cooked peas. With raw peas, when the temperature of a sample differed from 23° C. by 1 degree or more, a correction factor of —0.5 per ° C. was applied *(10)*. Comparable studies on cooked peas were carried out. The average tenderometer values at several different temperatures for 4 lots of peas were graphed. Straight lines were drawn and their slopes obtained. The increments were negative, as the tenderometer values decrease with rising temperature. The average increment was about —0.3 tenderometer unit per +1° C. (—1 tenderometer unit per +6° F.). This correction factor was smaller for tender peas and higher for tough peas, indicating that the relationship between tenderometer value and temperature may not be linear.

RECOMMENDED PROCEDURE

Frozen peas (1150 grams) placed in half their weight of boiling distilled water in a covered container are brought back to boiling in 9 to 11 minutes (heat adjustment is required). After 10 minutes of cooking (active boiling), the peas are drained and cooled to 73.4° F. (23° C.) by immersion in pre-cooled distilled water at about 5° C. The tenderometer grid is rinsed before and after each measurement with water at 23° C. If necessary, the temperature of the sample inside the grid cup can be adjusted by rinsing with distilled water at 23° C. A full grid cup (200 grams of drained peas) is used, and the 6 determinations per single cooked sample are averaged.

When less precision is required, the temperature of the peas can be measured after loading into the tenderometer grid cup or immediately after shearing. Temperature difference of a few degrees can be corrected by use of a factor (—0.3 tenderometer unit per +10° C., or —1 tenderometer unit per +6° F.).

The readings are made on the middle scale (No. 2) with the weights as used for raw peas. However, if the tenderometer is used for cooked peas only, more exact readings can be obtained on the lower scale (No. 1) with the appropriate weight on the pendulum (WCT-136 alone).

DISCUSSION

Modifications and sources of error. Errors in the tenderometer measurements occur unless care is taken to avoid them. One of the greatest is variation in effective cooking time of the sample. Since appreciable cooking will take place before boiling, adjusting conditions so that boiling is resumed within the specified time limits (9 to 11 minutes), is essential. The cooling conditions must also be standardized. Distilled or deionized water is necessary for cooking and immersion cooling, if toughening of the peas is to be avoided.

Other sources of error are: (1) insufficient replication and inadequate sampling, (2) uncontrolled temperatures, (3) changes in adjustment of the tenderometer itself, (4) hardness of cooking or cooling water, and (5) differences in elevation. Our studies were made at low elevation (nearly at sea level). At elevations which seriously lower the boiling point of water, preliminary experiments should be made to establish the proper cooking time.

Evaluation of procedure. Just how well the tenderometer measures the actual toughness or maturity of the peas is illustrated in Table 3. The data were calculated from a recent study *(10)*. Each lot of 18 to 24 samples represented 2 varieties and several harvest dates and size classes. The peas were carefully handled and uniformly processed. Table 3 shows values for the correlation coefficient *(r)* and the standard error of estimate *(S_{xy})* between the average tenderometer values for cooked peas and (1) their average cotyledon texture scores and (2) average percent alcohol-insoluble solids. S_{xy} is a measure of correlation; but unlike the more familiar correlation coefficient r, it is relatively uninfluenced by the total range of samples compared. The values of r and of S_{xy} show that the tenderometer measurements of cooked peas are closely correlated with the organoleptic scores of cotyledon texture and with the alcohol-insoluble solids content of the same frozen peas.

TABLE 3

Correlation coefficient (r) and standard error of estimate (S_{xy}) of tenderometer measurements on cooked peas vs. cotyledon texture scores (scores) and percent alcohol-insoluble solids (AIS)

Year	Varieties	No. of samples	r		S_{xy}[1]	
			Scores	AIS	Scores	AIS
1949	Thomas Laxton (T. L.) and Rondo	24	0.94	0.95	4.9	4.3
1950	T. L. and Oracle	20	0.98	0.98	4.4	4.2
1951	T. L. and Dark Seeded Perfection	18	0.97	0.98	4.5	3.4

[1] S_{xy} = standard error of estimate in tenderometer units from texture scores and from AIS.

The high correlation of alcohol-insoluble solids (AIS) and tenderometer values in these cooked peas is not surprising in view of the precision of the measurements and the unusual limitations on the growing, handling, and processing variables *(10)*. In frozen lima beans, Sterling and Boggs *(14)* have recently found that tenderometer values of cooked beans were well correlated with panel texture scores but not with AIS when handling, processing, or cooking conditions were varied.

Panel appraisal of texture is essentially a mechanical test carried out on the cooked product as eaten. The high level of correlation between panel scores and tenderometer measurements in the present work suggests the possibility of replacing in some cases the laborious panel appraisal of texture with the objective tenderometer method. Further research is needed, however, to establish the validity of the tenderometer method for peas of varied backgrounds. It will be necessary to compare the scores of a trained panel with tenderometer values on cooked peas grown in different localities and subjected to processing variables including "delay" (holding before blanching). Several varieties and maturities should be included.

It is reasonable to expect that a mechanical test with the tenderometer or comparable instrument *(6, 7)* would reflect toughness or tenderness better than chemical and physical tests now used, such as alcohol-insoluble solids, total solids, density, etc. Once its validity is fully established, the tenderometer (or other mechanical device) could replace the panel for the study of influence of storage and transportation factors as well as handling and processing variables upon texture of cooked peas. An objective method for such studies would not only be more efficient, but would also provide data that could be compared with those obtained at other times. Such comparisons are unreliable with organoleptic scores, because samples cannot be tasted together.

SUMMARY

A procedure was developed for use of the tenderometer to measure the textural quality of frozen peas

after they have been cooked under standardized conditions.

The results were closely correlated with panel appraisal of the texture of peas and with alcohol-insoluble solids, when the raw material variables were variety, harvest date, and size class.

The procedural variables investigated were cooking time, method of cooling, hardness of cooking and cooling water, amount of cooking water, weight and compression of peas in the tenderometer grid cup, and their temperature. Standardized conditions of cooking, cooling, and temperature are necessary for good results. Distilled or deionized water must be used to avoid toughening by calcium ions in tap water.

As compared to panel appraisal, the advantages of the tenderometer procedure include increased objectivity, speed, and reliability.

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Color Grading Foods With the Purdue Color Ratio Meter[a,b]

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Color often serves as a quality indicator for food products and, in many respects, is nature's method of indicating prime eating quality in natural foods. Color is an important factor in the standards for quality promulgated by the United States Department of Agriculture for many food products.

Visual grading of food for color is dependent upon the grader's ability to perceive color differences, and his judgment of the equivalence of the color of the product to the grade requirement in question. This ability is subject to fatigue, and is influenced by working conditions. Similarly, these factors are important in the regular quality control activity in food plants.

For certain commodities it appears possible to overcome the inherent difficulties of subjective color evaluations. The Hunter Color and Color Difference Meter has been found to be applicable to a number of color grading situations *(3, 6, 8, 10, 12, 13, 14)*. It is a tri-stimulus color meter, and gives accurate and reproducible results. With tomato and tomato products, the Hunter a_L/b_L value has been found to be related closely to hue *(12)*. It has been possible to describe a term such as "90% good red color" in terms of the Hunter units *(8)*. It is thus possible to compare the grade interpretations in one area to those of another. It is most important that the color line for grade divisions be fixed or stable, for instance in the marketing of 500,000 tons of tomatoes through 100 inspectors in this state. It was thought that perhaps the Hunter instrument was applicable to the job. Attempts in two separate years to indoctrinate raw product inspectors in this area to the use of a tri-stimulus color meter proved fruitless. It was apparent that a more simple approach would have to be taken. There is a need in our industry for objective, easily operated, color grading instruments.

[a] Journal Paper No. 732. Purdue University, Agricultural Experiment Station, Lafayette, Indiana.

[b] Presented at the Thirteenth Annual Meeting of IFT, Boston, Mass., June 22, 1953.

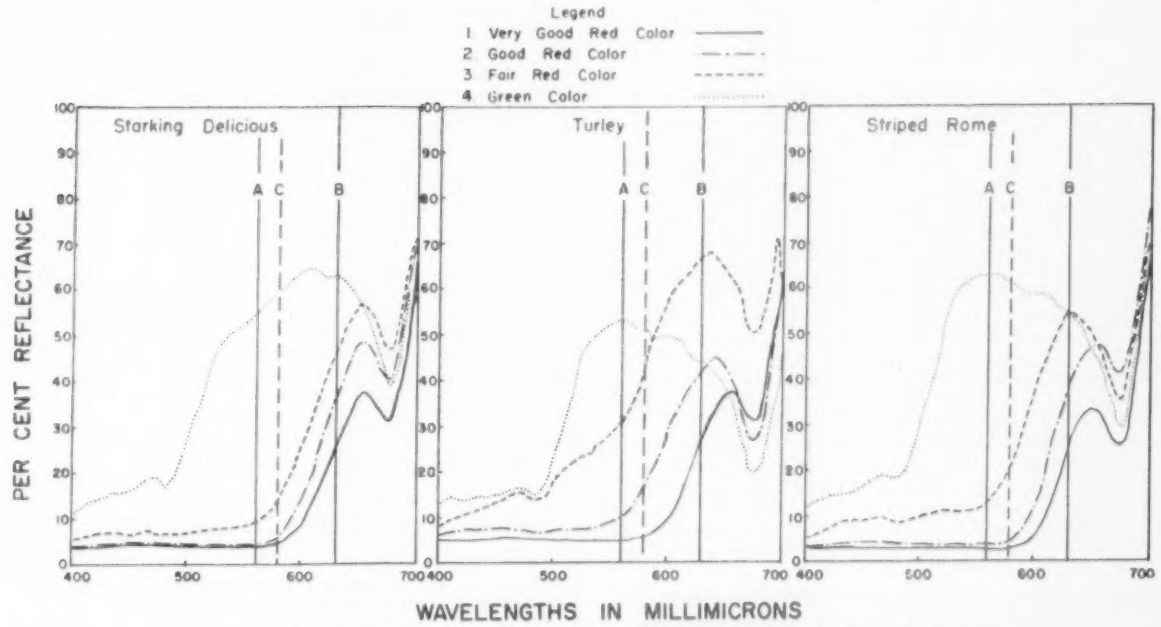

Figure 1. Spectral analyses of Starking Delicious, Turley, and Striped Rome apple color.

DEVELOPMENT OF THE PURDUE METER

The spectrophotometer is recognized as a basic instrument in the fundamental standardization of color *(1)*. The recording spectrophotometer automatically and continuously marks the percent reflectance for wavelengths between 400 and 700 mμ. Typical results of such analyses for three common apple varieties of various color grades are shown in Figure 1. Similar curves for a green and a fully ripe tomato are shown in Figure *2*. These curves led to the belief that it would be possible to construct a photoelectronic grading instrument.

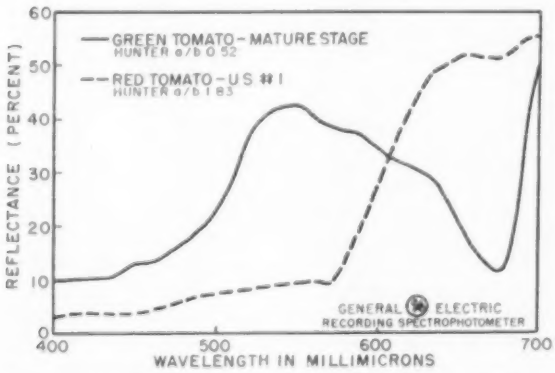

Figure 2. Characteristic spectral reflectance curves for a green and a red tomato.

The ripening of a green tomato through to the red ripe stage is followed closely by the percent reflectance at a wavelength of 680 mμ (Figure *2*). At this wavelength the difference between U. S. No. 1 and U. S. No. *2* color was approximately 10%. Measurement of the fruit at this wavelength was tentatively not considered feasible for grading the various qualities of red tomatoes due to the small range of color in question and the corresponding small change of reflectance values. The second method of separating the three color grades (U. S. No. 1, U. S. No. *2*, and cull) was with the measurement of reflectance at two bands of the spectrum. The maximum difference as measured by percent reflectance between the grades was found to be in the spectral regions near 640 mμ and 560 mμ (Figure *2*). Color at 640 mμ is red, and as the fruit matures the percent reflectance at this wavelength increases. The color at 560 mμ is yellowish-green, which gives a decreasing value for the percent reflectance as the fruit matures. Thus, as the fruit ripens from the turning stage of pale yellow to red ripe, there is a simultaneous rise in reflectance at 640 mμ and a decrease in reflectance at 560 mμ. Based on the percent reflectance at each of these 2 wavelengths the value for the red/yellow ratio would be small for a green or poorly colored fruit, and large for a red ripe fruit. Based on the above information a photoelectronic color meter was designed and constructed through the Campus Electronic Service *(9)* at Purdue University. The instrument was designed with the concept of simplicity and this led to several innovations. Because the objects to be evaluated were irregularly shaped, a circular fluorescent lamp was used as a light source. This particular tube emits little infrared radiation, to which available photo tubes were sensitive. The fruit specimen holder is located directly above the geometric center of the circular tube, in the same plane with the fruit specimen. Alternate red and yellow filter photocell units are evenly spaced around the circumference of the fruit, see Figure 3. The red circuit is composed of Argus red filters and RCA type 922S-1 photocells which are sensitive in the spectral region of 620 to 650 mμ. The yellow circuit is composed of dark yellow Argus filters and companion photocells RCA type 926S-3, sensitive in the spectral region of 540

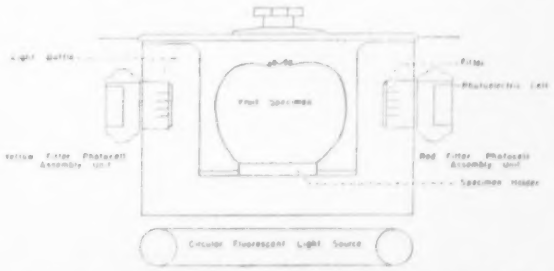

Figure 3. Vertical section—diagrammatic drawing of Purdue Color Ratio Meter Model No. 360-A indicating specimen, filter, photocell and light source arrangement.

to 580 mμ. Ten filter photocell units are employed. After proper calibration the instrument is ready for use. With such a system the red/yellow ratio for a specimen is indicated on the instrument dial.

COLOR EVALUATION OF FOODS

From the spectral reflectance curves for tomatoes (Figure 2), it was anticipated that the red/yellow measurements of the Purdue Meter would be correlated with visual interpretations of external tomato color. Because of the highly significant relation between visual color interpretations and Hunter Meter values *(10, 12)*, the Hunter instrument was employed to evaluate the Purdue Meter. The relations between Purdue Meter values and the Hunter Meter values for outside (or surface) tomato color are shown in Figures 5 and 6. More than a thousand samples are represented in this figure. The Hunter Meter values were obtained by averaging the a/b ratio obtained from three randomly selected areas around the equator of the fruit. The Purdue Meter values represent the average of duplicate readings for the same fruit. Figure 6 shows the relationship between the Purdue Meter values and the Hunter Meter values for tomato juice samples. The sample juices were placed in a round bottom flask for analysis as shown in Figure 4.

Essentially the application of the Purdue Color Ratio Meter to the problem of evaluating the color of red apples may be demonstrated in Figure 1. If the reflectance value indicated by line "B" for a sample is divided by the reflectance value indicated by line "A" for the sample, it will be seen that the "B" value/"A" value ratio results in a system which highly correlates with the visually evaluated color for a particular specimen. It should also be pointed out that the reflectance values for the various samples indicated on line "C" in the above figures would also be of value in objectively color grading these samples. It will be noticed that line "C" reflectance values (approximately 580 mμ) would segregate the poorly colored fruits better than the well colored fruits. The relationship between the percent good red color visually assigned by a panel for the several varieties of apples, and the corresponding Purdue Color Ratio Meter values for these varieties are given in Figure 7. The correlation coefficients for Winesap, McIntosh, Delicious, Starking Delicious, Turley, and Striped Rome apple varieties were found to be .89, .90, .81, .97, .89, and .92, respectively *(4)*. These values indicate that a good degree of correlation exists between the visual observations and the values obtained with the Purdue Meter. From the data obtained for each variety, regression lines were calculated and plotted. The Purdue Meter values for the various apple color requirements of the U. S. grades for a variety may be found from these curves.

Studies with the Purdue and Hunter meters with a number of commercial catsup samples are indicated in Figure 8.

A number of frozen strawberry, frozen raspberry, and strawberry jam samples were evaluated for color as above. Fruits were mashed prior to color measurement. The averages of 3

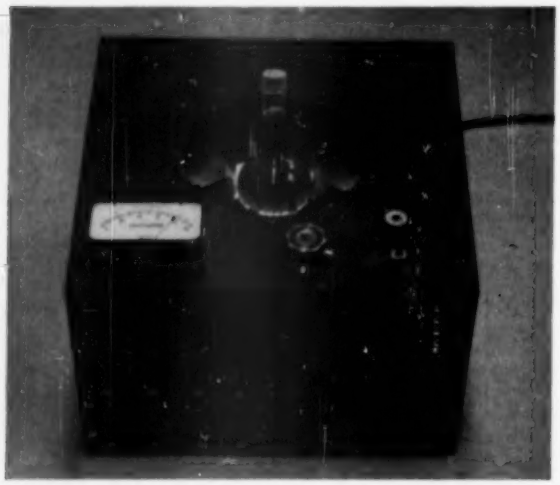

Figure 4. Purdue Meter with tomato juice in position to be evaluated for color.

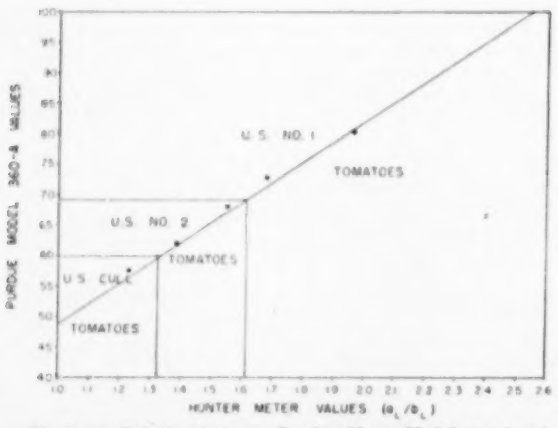

Figure 5. Relation between Purdue Meter Model 360-A values and Hunter Meter values for outside tomato color.

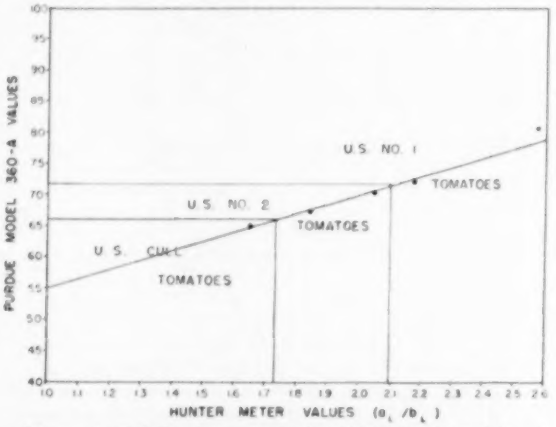

Figure 6. Relation between Purdue Meter Model 360-A values and Hunter Meter values for tomato juice color.

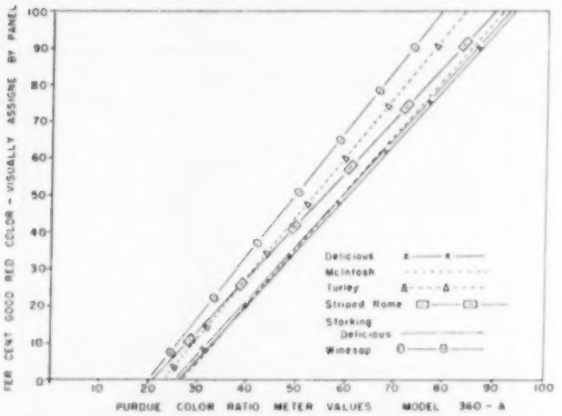

Figure 7. Relation between percent good red color, visually assigned, for several varieties of apples, and Purdue Color Ratio Meter—Model 360-A values for these varieties.

Hunter Meter values for samples were plotted against Purdue Meter values. Typical results are shown in Figure 9 for these small fruit products.

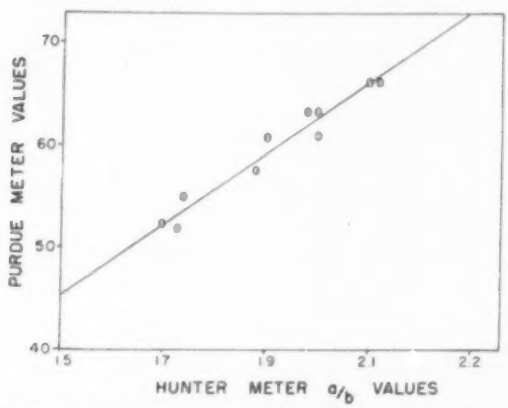

Figure 8. Relation between Purdue Meter and Hunter a/b values for commercial catsup samples.

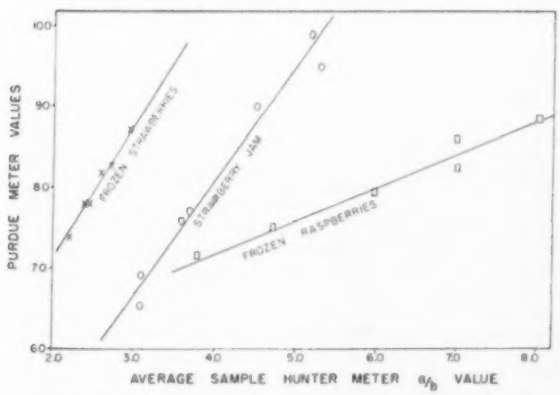

Figure 9. Relation between Purdue Meter and Hunter a/b values for commercial strawberry jam and frozen strawberry and raspberry samples.

DISCUSSION AND SUMMARY

The Hunter Color and Color Difference Meter is a tri-stimulus instrument. As has been shown by many workers, the Hunter a/b (red/yellow) ratio for tomato samples is closely related to hue. Hue has been shown to be the factor by which inspectors grade such commodities as tomatoes and tomato products *(12)*. The Purdue Color Ratio is not a tri-stimulus instrument. However, it appears that in the instance of such items as apples, tomatoes, and some other products, an instrument other than a tri-stimulus one may be highly efficient in objectively evaluating color as seen by an experienced panel. The tri-stimulus type of instruments are necessarily complex. Three factors must be evaluated. When the situation is such that a system other than a tri-stimulus one is capable of evaluating objectively the color of a sample with good accuracy, the problem is greatly simplified. While the Purdue Color Ratio Meter is not a multipurpose type instrument, it is felt that for certain agricultural commodities where the red/yellow ratio is a good indicator of the visually perceived color, the instrument may be of interest *(2, 4, 5, 6, 7, 8)*. The simplicity, ease of operation, ruggedness, and inexpensiveness of the meter [c] bring it to the level of a practical field-type grading instrument. The Purdue Meter is inadequate in its interpretations of predominantly yellow or green objects, necessarily so by its inherent design.

For particular food color evaluating situations, it is believed that simple electronic devices may be constructed which would have great accuracy for quality control types of examination. For instance, the color score of every code and lot of tomato juice manufactured commercially in a nearby factory was obtained and recorded by the quality control personnel. The sample of juice secured for mold counting later was used for the color assay.

One of the weaknesses found in the Purdue Meter has been associated with non-uniformly colored samples. To overcome this feature an instrument was designed in which the specimen holder was made to rotate 35 r.p.m. The instrument with the rotor attachment is shown in Figure 10. There are three red and three yellow filter photocell units in the shown figure. The electronic circuits are basically those of the regular unit *(9)* with the exception of a feature for stabilizing the needle on the dial. With the rotor attachment, fruits with very non-uniform color distribution are evaluated.

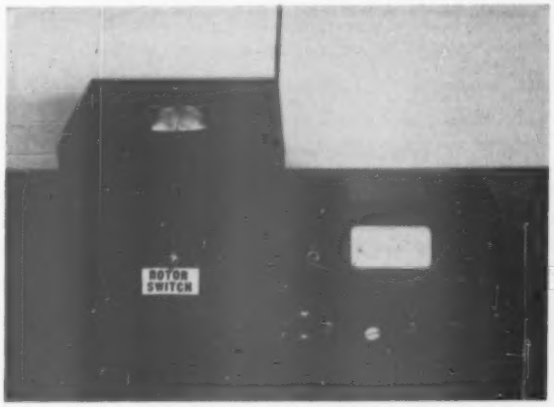

Figure 10. Purdue Meter with specimen holder that revolves 35 r.p.m.

In addition to the rotor type Purdue Meter an instrument with sensitivities in the yellow and green region of the spectrum is being developed in these laboratories.

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[c] Could be sold commercially for about $350.

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Preparation of Fresh Italian Prune Juice Concentrates

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(Manuscript received August 24, 1953)

Information is presented concerning conversion of Italian prunes into attractive and tasty juice and juice concentrate products. Description of the process, equipment needed, and results of investigations of the effects of maturation before harvest, removal and return of essence, temperatures during concentration and temperatures during storage upon the product are included.

The Italian or Fallenberg variety of prune, similar in character to those varieties raised in southeastern Europe, is the principal variety grown in the Pacific Northwest. The fresh market and the canned product are the two principal outlets for this variety of prune. In the last few years, production has exceeded the demands of existing outlets. As a result, prices for the raw fruit have been depressed and considerable work has been done by several groups in efforts to develop increased demand.

Studies have been reported on problems related to canning of Italian prunes *(1, 5)* and more recently on the preparation of juice and juice concentrates from fresh Italian prunes *(3, 4)*. Numerous inquiries from people interested in producing juice or juice concentrates have indicated a need for publication of more detailed information on the subject than is now currently available.

This paper reports the results of studies of factors involved in preparation of juice concentrates from fresh prunes. The studies, which have been in progress for several years, were made in cooperation with the Washington State Fruit Commission. They have resulted in the development of a process for converting fresh prunes into either a single-strength or a concentrated juice possessing a striking red color and a pleasing, tart flavor if prunes fully matured before harvest are used.

[a] Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

PREPARATION OF JUICE

Fresh Italian prunes can be converted into juice in much the same manner as French prunes *(10)*. The method used in this Laboratory consisted of the following steps: Prunes were washed in cold water and enzymes were inactivated by blanching whole fruit in steam to a negative catechol test *(8)* (8 to 9 minutes at 212° F.). To prevent loss of coloring matter and soluble solids leached from the prunes by condensed steam, they were blanched on solid trays. Retention of color is particularly important to assure adequately pigmented juice. The method can be considered as a close approximation to that in which a screw-type cooker or blancher is used. Blanched prunes were fed directly into a paddle finisher which separated pits and produced a puree consisting of finely divided flesh and skins. Puree was treated with a pectic enzyme preparation (Table 1) prior to pressing, as such treatment resulted in a doubling of yield and an 80% reduction in filter cel requirements. Juice recovery was carried out in a bag-type press with 1.5 to 2.0% of filter cel as a pressing aid. Because of its consistency, Italian prune puree could be pressed only with extreme difficulty in a rack-and-frame press. Pressed juice was clarified in a pre-coated horizontal plate pressure filter with approximately 0.25% filter cel as an addition to the juice.

TABLE 1
Time-temperature-concentration values for treatment of Italian prune puree with pectinol A[1]

Concentration of Pectinol (wt. % addition)	Time (hrs.) at 75° F.	Time (hrs.) at 100° F.
0.1	18	6
0.2	5	3.5
0.3	2.5	1.5

[1] Mention of this product is illustrative but not restrictive, and cannot be considered as an endorsement of this particular product or manufacturer.

The sparkling clear juice obtained by this process was of a rich scarlet color and, when obtained from mature prunes, of a pleasingly tart flavor. The yields obtained were high (Table 2) compared with those of most fruits. Values listed in Table 2 have been corrected for dilution with condensed steam (about 5 to 6%) that occurred in the blancher.

PREPARATION OF CONCENTRATE

Studies concerning preparation of fruit-juice concentrates follow two general lines of investigation. The first is concerned

TABLE 2
Laboratory yield data in the manufacture of clarified juice from Italian prunes

Operation	Yield %[1]	Losses	
		Amount %	Type
Blanching	100.0	0.0	.....
Pulping	94.2	5.8	Pits, etc.
Pressing	83.2	11.0	Flesh and skins
Clarification	81.2	2.0	Filtration cake loss

[1] All percentages are based upon the weight of prunes after washing and corrected for dilution with condensed steam from the blancher.

with information relative to volatile flavor constituents present in the juice and the second with limiting conditions of time and temperature during concentration. Volatile flavor constituents can be recovered by stripping them from the juice prior to concentration *(2, 7)* while limiting conditions during concentration can be determined in a falling-film evaporator *(9)*.

It was found that recovered volatile flavor constituents from all but the most mature prunes were of practically no value in enhancing the flavor of a reconstituted concentrate. In the case of juice from the most mature prunes, return of recovered volatile flavors definitely enhanced the final flavor. The degree of enrichment in flavor can be described as changing a very good product into an excellent one.

Clarified prune juice can be concentrated at an absolute pressure of 4 inches of mercury in a falling-film evaporator to as high as 75° Brix without any particular difficulty. This represents a fold-by-volume concentration of 4 to 5.4, based on the normal soluble solids range of Italian prune juice (24 to 18%) and would permit packing of the usual 4-fold type of concentrate.

Tests were made in a falling film evaporator to determine the maximum operating pressure (and hence temperature) at which concentration could be carried out without affecting the flavor of the reconstituted product. Portions of a batch of juice were concentrated at various operating pressures, and products of concentration were recombined for flavor evaluation. The evaporating period for each run was 120 ± 5 minutes and the temperature rise during concentration approximately 5° to 6° F. (2.8° to 3.3° C.). Organoleptic evaluation showed that Italian prune juice is relatively stable against heat. The panel was unable to distinguish between juices concentrated at operating pressures ranging from 1.25 to 9.50 inches of mercury (equivalent to boiling points of water of 85° F. and 160° F., or 29.4° and 71° C., respectively).

STORAGE EXPERIMENTS

Four-fold concentrates, both hot and cold pack, showed no noticeable changes in either flavor or color during storage at —10° F. (—23.3° C.) over the period of one year. However, definite changes during this period of time were observed in samples stored at 75° F. (23.8° C.). The hot-packed samples were prepared by heating concentrate to 200° F. (93.3° C.) in a single-tube heat exchanger (1-2 seconds), filling into 6-ounce "H" enameled cans, sealing and inverting for 2 minutes before cooling in running cold water. The cold-packed samples were filled cold, sealed, and frozen at —10° F.

The color changes resulting from storage at 75° F. were of a type normally occurring in juices containing anthocyanin type pigments, i.e., a shift from the red toward the brown. Objective measurements of changes in color of one of the concentrates after 6 months' and 1 year's storage are shown in Figure 1. Concentrates were reconstituted to original soluble solids content before color measurements were made with a spectrophotometer. In terms of visual color, the net change at the end of 6 months was small, while that at the end of a year was quite noticeable, although to the eye red still predominated and the color was fairly attractive. Concentrates that had been packed in glass (5 oz. baby food jars with white cap) showed approximately the same degree of color change, regardless of whether storage took place in daylight or in the dark.

The flavor of juice reconstituted from concentrates stored for 6 months at 75° F. had not deteriorated appreciably, but that of concentrates stored for one year had developed both oxidized and caramelized types of off-flavor.

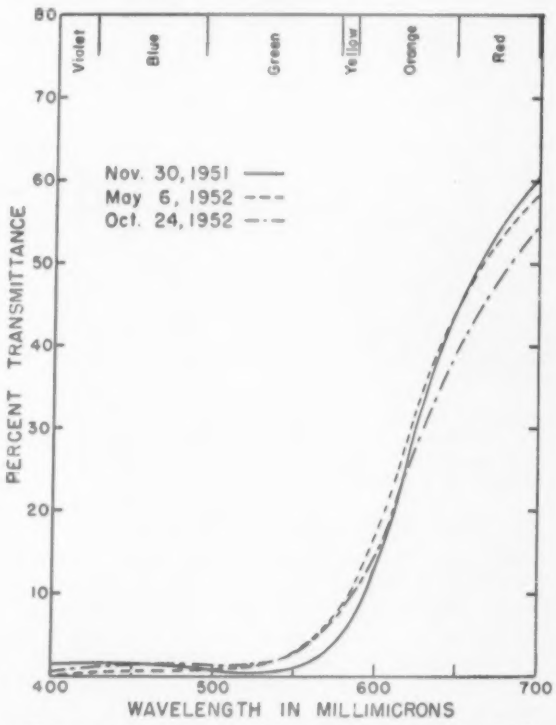

Figure 1. Color changes taking place in concentrated Italian prune juice during storage at 75° F.

EFFECTS OF PRUNE MATURITY

Our experience with Italian prunes has shown that only a mature prune will produce a satisfactory juice or juice concentrate. In trade terminology, prune maturities are generally expressed as being of "fresh market," "canning" or "drying" maturity. We have found that juice obtained from prunes of "fresh market" maturity is light in color, exceptionally tart in flavor, and lacking in aroma. It tends to darken during storage at a faster rate than juice from more mature prunes. Juice from prunes of "canning" maturity is good in color, very tart in flavor, and somewhat lacking in the full aroma of juice from fully mature prunes. Juice from prunes of "drying" maturity (for instance, from the second harvest in the Vancouver, Washington, area) has an excellent color and a fully rounded, fresh-prune flavor. Of the 3 general types of maturity, juice obtained from the first can be considered as having doubtful acceptability, juice from the second as being useful after the addition of sugar and perhaps water to lower its tartness, and juice from the third as being a superior and attractive product.

The importance of using fully mature prunes as a source of juice cannot be over-emphasized. Total acid concentration in prunes drops rapidly during the later stages of maturation (from about 1.0% to about 0.6%) and a typical and pleasing aroma develops strongly during this period. In the opinion of those who have tasted these juices, a juice with a total acid concentration of about 0.6 to 0.7% is a pleasing beverage, but one with a concentration of 1.0 to 1.2% is not acceptable unless the concentration has been reduced by the addition of water and sugar.

PREPARATION OF PRUNE DRINKS

The degree of maturity economically attainable will vary in different regions, as climatic conditions during the harvest season (rain or wind) may force an early harvest. Hence, studies of means for utilization of juice from prunes harvested at lesser

degrees of maturity than the ideal were made in conjunction with this work. As some of the juices obtained were far too tart for the average palate, experiments designed to evaluate modified juices were carried out. Sufficient water was added to reduce the total acid concentration and sufficient sugar added to raise the soluble solids to that of a typical juice from fully mature prunes (total acid concentration expressed as malic acid of about 0.63% and soluble solids concentration of about 22%).

As an example, 40 parts of water and 12.2 parts of sugar were added to 100 parts by weight of a juice having a total acid concentration of 0.89% and a soluble solids concentration of 21.8%. The resultant drink was considered to be equal in color to that of juice from mature prunes and highly palatable, but slightly inferior in taste, as it appeared to lack the fully rounded aroma of juice from prunes which had fully matured on the tree. Concentrates of these juices were made by concentrating juice to the desired degree, dissolving the necessary sugar in the concentrate, and packing. In the particular example given above, addition of 32.2 parts of sugar per 100 parts of concentrate containing 61.1% soluble solids would produce a four-fold concentrate of this prune drink.

Such a procedure as outlined above will greatly improve the palatability of juices from prunes of average "canning" maturity. However, so little typical prune flavor and aroma are found in juice from prunes of "fresh market" maturity that the procedure is of little use for this type of prune.

COMMERCIAL APPLICATION

Laboratory methods outlined above should be readily adaptable for commercial use, because the required pieces of equipment are commercially available. Use of a screw-type blancher (such as an apple sauce cooker) is recommended. A bag-type press is recommended in preference to the rack-and-frame type, because the puree is too thin to allow a firm stand of cheeses and frames. The decision as to the time-temperature-enzyme concentration combination needed for pectic enzyme treatment depends upon the type of operation planned; treatment at the higher temperature and enzyme concentrations is more adaptable to continuous operation.

Concentration can be carried out in equipment and under conditions of time and temperature that are suitable for production of beverage-type grape or apple concentrate *(6)*. Although experimental results indicate that Italian prune juice can withstand appreciably higher temperatures during concentration than apple or grape, it is expected that the manufacturer would plan to concentrate more than one type of juice and hence purchase equipment suitable for the various types of fruit produced in his local area. Insertion of an essence-stripping unit prior to concentration would be beneficial if the prunes are expected to be quite mature, and quite necessary if the management intends to concentrate other types of juice, such as apple or grape, which require essence recovery for manufacture of a superior product.

Storage tests show that frozen four-fold concentrates are stable over the period of one year. Sterile or hot-pack concentrates can be stored for a short period of time at 75° F. (24° C.) without serious deterioration. Tests made, however, indicate that 6 months may be considered to be the absolute maximum, for some deterioration in both color and flavor were noted at the end of this period of time. Tests were not made at intermediate temperatures, but it is expected that storage in the neighborhood of 40° F. should prolong the storage life considerably, for deteriorative changes in color and flavor of fruit juices are slowed down as the temperature of storage is lowered.

SUMMARY

A process is described and equipment needs outlined for the preparation of single-strength and four-fold concentrated Italian prune juice from fresh prunes. Concentration can be carried out in the laboratory at the relatively high absolute pressure of 9 inches of mercury without adversely affecting the product. The value of essence recovery is debatable and depends upon the particular raw material used.

Prunes must reach full maturity if a top-quality juice or juice concentrate is to be prepared. In those areas where full maturity is not economically feasible, dilution of the juice or concentrate with sugar and perhaps water to reduce the astringency will result in a potable juice.

Four-fold concentrates can be stored for one year at —10° F. without noticeable changes. Sterile concentrates stored at 75° F. for 6 months showed some deterioration in color and flavor. At the end of one year, both color and flavor had deteriorated appreciably.

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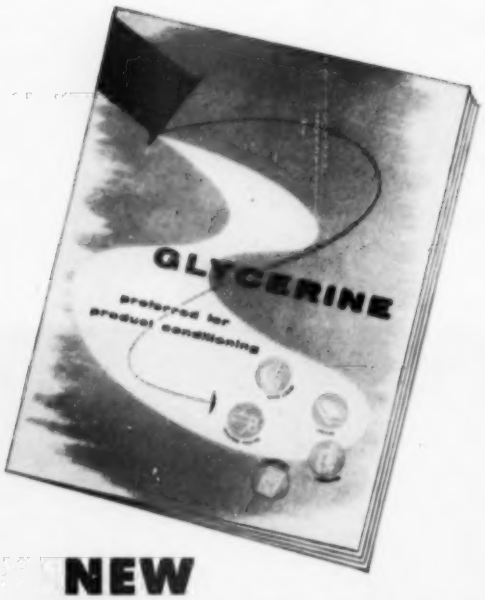

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ANNUAL MEETING BULLETIN BOARD

(Continued from page 24 preceding technical papers)

registration fee will be required. Extra tickets and tickets for events scheduled after the printing of the Preregistration Application Form will be obtainable at the EXTRA TICKET SALES window in the Galeria of the Biltmore Hotel only after members have registered and obtained their badges. *Acknowledgment of receipt of applications and payment will be mailed by the Registration Committee between June 1st and June 15th.* The numbered acknowledgment card will be a receipt which will serve as identification for registrants picking up their envelope of tickets and badges at the PREREGISTRATION DESK in the Galeria of the Biltmore Hotel. Preregistration will be a convenience for you and a saving for IFT. Please send your PREREGISTRATION APPLICATION NOW to L. B. Rockland, Chairman, Registration Committee, Institute of Food Technol., 263 So. Chester, Pasadena 5, Calif.

ANNUAL MEETING TECHNICAL PROGRAM KEEPS PACE WITH GROWTH OF THE INSTITUTE

The technical program to be presented at the Los Angeles meeting (June 27-July 1, 1954) is indicative of the growth of the Institute, both as to the number of papers to be delivered—well over 180—and the number of fields of interest covered. Although the program covers the established categories—fruit and vegetable research and technology, fish and meat technology, sensory testing of foods, food packaging, and so on—symposia and sessions have been added that are either new to IFT meetings or novel in their organization.

Roy Walters' session (June 29) on marketing, for example, adds a new note to IFT annual meeting agenda. Business opportunities in the grocery field, food advertising, marketing and distributing foods, and the evaluation of marketing programs will be the topics, and the subject matter will suggest many appplications for the technologist working to develop new products or to improve existing ones. Harold Berg's session (June 28) on wine stability includes eight papers, many of them by research workers affiliated with the great wine manufacturers of the California area. Such influences on the stability of wine as the nitrogen content of the must, pH and total acidity, enzyme introduced as a stabilizer, sulphur-dioxide—these are some of the topics to be considered by the wine specialists.

Monday, June 28, will be a full day. Several papers relating to poultry, eggs, and milk, respectively, will be presented at George Stewart's session (June 28). Among the contributions to this session will be one on acetoglycerides—new fat products of potential value for the food industry. E. B. Oberg's session (June 28), devoted to research papers, contains interesting reports of work done on the antioxidant properties of natural spices, on maple sirup, on flor yeast, on flavor evaluation, on continuous pressure filtration, as well as other studies.

"Special Purpose Foods"—that is, foods for children, for the aged, and for medical diets—will furnish food technologists with background on the problems inherent in formulating and manufacturing these types of foods. Several medical scientists are participating in this session.

Helen Hanson's session (June 29) on consumer testing is closely held to methodology and techniques. The organizations contributing their experience with various scales and tests are the University of California, the Quartermaster Institute, the Western Utilization Research Branch (formerly the Western Regional Research Laboratory), General Mills, Thomas J. Lipton, Inc., Kraft Foods Company, and the Massachusetts Institute of Technology. Although not located in this session—which is confined to consumer testing—the U. S. Testing Company, the University of Illinois, the University of Maryland, Cornell, the Ohio State University, the State College of Washington, Oregon State College, the University of Wisconsin and others contribute findings that relate to the sensory testing of foods in connection with other sessions. This whole field will receive much emphasis during the meetings.

Federal and state food and drug laws are to be analyzed and discussed in the session (June 29) to be conducted by Charles W. Kaufman. E. J. Cameron, F. N. Peters, Emil Mrak, J. P. Esty, H. J. Deuel, Elizabeth Elbert and Carl Fellers are among those who will present formal papers on these topics. A. M. Gilbert of Davis and Gilbert, New York City, Counsel for Best Foods, will speak on the Federal law and proposed amendments as they affect food standards as the closing feature of Kaufman's session.

Of great interest on Tuesday morning, June 29, will be the session in appreciation of Edwin Bret Hart famous University of Wisconsin scientist, whose name will also be commemorated in the Babcock-Hart Award. Under the chairmanship of L. E. Clifcorn, the life and accomplishments of this learned biochemist will be described. The Wednesday morning general session will be the occasion for the Nicholas Appert Award address and the Babcock-Hart Award address. These are notable occasions each year at the IFT meetings.

Kenneth Brighton's group will discuss "What's New In Packaging," (June 29) and in this connection will cover plastic films, paperboard containers, metal containers, glass containers, and shipping containers—in all, six papers of unusual merit. The pectin chemists will foregather with Reese Vaughn to hear a set of formal papers, and will delve further into this complex subject at a Tuesday evening "pectin round table."

Problems in fruit and vegetable research and technology will be considered by numerous specialists in this field—in John MacGillivray's session (June 28) H. W. Schultz' session (10 papers, July 1), and by J. R. Wagner's session on fruit and vegetable dehydration (June 29, eight papers) as well as in J. P. Moster's session (11 papers, July 1), and in K. G. Dykstra's session on frozen foods (June 29). In a session conducted by M. Simon (June 29)—which extends the dehydration discussions—a resume of research being done in the United Kingdom will be presented. Frank Gunderson's group

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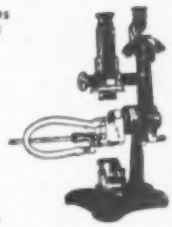

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will report (June 29) the results of research in the comparatively new field — irradiation sterilization — sometimes called "cold sterilization." The use of irradiation in eradicating insects in packaged rations, basic considerations with respect to liquid foods, and "food physics"—something new in the world of research and technology — are among the papers in Gunderson's session.

Citrus concentrates, one of the great achievements of recent research and technology in the food field, will receive attention on Thursday, July 1, under the chairmanship of W. R. Roy. The papers, some 17 all told, that feature the program for this session range from the food engineering aspects of concentrates to the bacteriology of these products.

In so excellently organized a total program it is impossible to pick out one program and say "this is a *must.*" However, attention should be called to Curtis Maier's well-rounded treatment of "food engineering." (July 1). The integration of food engineering, food technology, and food science will be made clear and for those looking for the overall view, this session should be kept in mind. A panel on instrumentation in the modern food plant should have special appeal for food engineers and technologists.

The effect of chemicals (pesticides, etc.) on flavor will be examined at C. H. Mahoney's session (July 1). A feature of this program, will be a report on studies designed to arrive at a "standardized procedure" for making flavor evaluations of canned foods treated with chemical pesticides. These studies were a cooperative effort on the part of several organizations.

Aksel Olsen's session (July 1) will include interesting new findings on the role of fats in the diet, the antibiotics in nutrition, and recent advances in stabilizing foods. Fish and meat research will be covered by the session to be conducted by M. J. Copley (July 1).

The foregoing are a few of the highlights; the complete program, with abstracts, will appear as usual in the May issue.

FUTURE DATES FOR FOOD TECHNOLOGISTS

1954	
April 22-23	National Meeting of the American Dry Milk Institute, Edgewater Beach Hotel, Chicago, Ill.
April 25-28	Annual Meeting of The Refrigeration Research Foundation, Boca Raton, Florida
April 27-28	Annual Meeting of the National Cheese Institute, Chicago, Ill.
May 2-5	**Annual Meeting of the National Fisheries Institute, Cleveland, Ohio**
May 16-19	Flavoring Extract Manufacturers' Association, Biltmore Hotel, New York, N. Y.
May 19	Fruit and Syrup Manufacturers' Association, New York, N. Y.
May 26-28	*Fourth Annual Convention, Australian Regional Sections, Institute of Food Technologists, Leura, New South Wales, Australia.*
June 23-25	Seventh Annual Meeting of the Research and Development Associates, Food and Container Institute, Los Angeles, California
June 27 to July 1, 1954	**Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

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The Special Summer Program in Food Technology, an annual feature of the Summer Session at the Massachusetts Institute of Technology, will this year for the first time include **specialized study in one of 4 different fields of food technology.** The 1954 program, according to Prof. Ernest H. Huntress, director of the MIT Summer Session, is scheduled for 3 weeks from July 12 through July 30. After 2 weeks of study together, members of the program will divide into 4 groups for a final week of specialized work in sanitation, nutrition, flavor acceptance, or radiation sterilization. Tuition for the 3-week program will be $150. Application blanks and further information may be obtained from the Summer Session Office, Room 7-103, MIT, Cambridge, Mass.

◆ ◆ ◆

A spokesman for a leading chemical manufacturer told a meeting of food technologists in Los Angeles recently that **certain revisions are needed in the Federal Food, Drug and Cosmetic Act,** but stated that such changes should not unduly interfere with the orderly marketing of new chemical food additives. Mr. John J. Powers, Jr., senior vice president of Chas. Pfizer & Co., Inc., asserted that nowhere in the chemical industry had he encountered opposition to the Food and Drug Administration's desire that the law be amended. "However," he cautioned, "revision of the Act should be effected so as to achieve the required objectives with a minimum impact on the orderly marketing of new products." Mr. Powers called on the food technologists to direct their attention toward assuring that public opinion bearing on the problem of chemical food additives is an informed and educated one.

◆ ◆ ◆

A new $4,000,000 building in Cincinnati, O., housing the Sanitary Engineering Center of the Public Health Service, was dedicated on April 8 by Mrs. Oveta Culp Hobby, Secretary of the Department of Health, Education and Welfare. The Center is the focal point of the Federal Government's research and study into how the health of human beings may be affected by contacts with elements found in air, water, and food, and by radiation and other factors in the environment. On the second day of the 2-day dedication program, a scientific symposium dealt with the general subject, "The Control of the Environment for the Health of Men." Principal speakers were Dr. Oram Woolpert, Ohio State Research Foundation; Dr. Detlev

(Continued on page 36)

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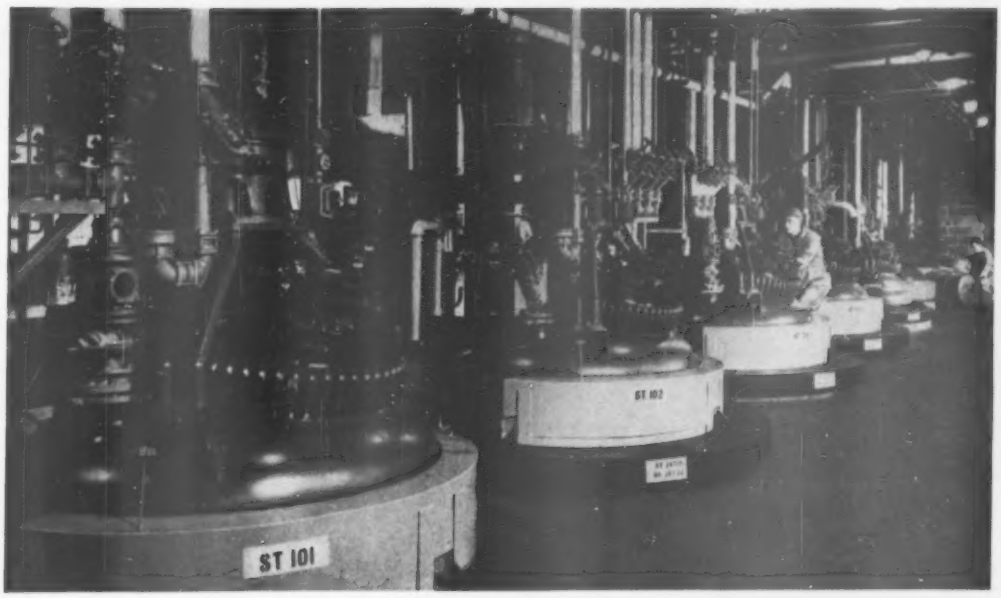

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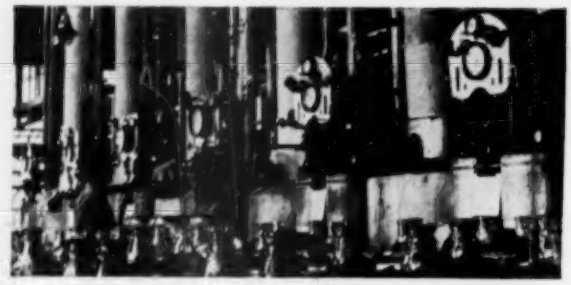

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FOOD INDUSTRY TOPICS

(Continued from page 34)

W. Bronk, Rockefeller Institute for Medical Research; Dr. Gordon M. Fair, Harvard University; and Dr. Herman E. Hilleboe, American Public Health Assn.

◆ ◆ ◆

The specialty of **clinical nutrition** is now becoming recognized as important in every medical field, according to Dr. Robert A. Peterman, recently named medical director to J. B. Roerig & Co., who addressed the western section of the American Pharmaceutical Manufacturers Assn. Recounting experiences in a nutrition clinic in New York City, Dr. Peterman reported that requests for nutritional evaluation of patients from such specialties as ophthalmology, neurology, surgery, orthopedics, and dermatology are becoming routine. "The new concept of metabolic medicine," Dr. Peterman emphasized, "means that there exists a tremendous opportunity to provide for the practicing physician a number of carefully designed nutritional products to be taken daily by the patient . . . new products with each individual ingredient being completely justified by valid evidence of its need or usefulness."

◆ ◆ ◆

A grant of $100,000 by the Campbell Soup Fund will finance the 200-seat auditorium of the projected **Drexel Basic Sciences Laboratories Center,** according to Dr. James Creese, president of Drexel Institute of Technology, Philadelphia, and Mr. J. T. Dorrance, president of the Fund. This grant by the Campbell Soup Fund brings to $1,115,000 contributions of local corporations, foundations, and alumni and friends of the Institute for facilities of the projected Basic Sciences Center.

◆ ◆ ◆

Breakfast bacon may taste better and keep longer because of a Swift and Company grant of $5,000 to Florida State University for a **research project on oxidative changes in meats.** Dr. Betty M. Watts, professor of food and nutrition in the FSU School of Home Economics, will supervise the research program under the grant. This is one of a number of grants Swift has made during the past several years to universities for basic research work in nutrition and food science.

◆ ◆ ◆

The growth of the **American Association for the Advancement of Science** from its beginning in 1848 is saluted in the February 1954 issue of *Industrial Bulletin*, published by Arthur D. Little, Inc., Cambridge, Mass. As evidence of the present massive importance of the AAAS, the *Bulletin* points to the recent 120th meeting where "a program of 300 technical sessions and 1200 papers covered the scientific gamut from astronomy to zoology and provided a unique opportunity for specialists to broaden their outlook through mutual exchange." Present aggregate membership of the AAAS now is in excess of a million, with 245 societies in an affiliated capacity.

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Fresh-frozen "Shrimpburger" overwraps are the latest addition to a growing line of **full-color, stock-design frozen food wraps** created by Western Waxed Paper Division, Crown Zellerbach Corp., San Leandro, Calif. Stock design overwraps, originated several years ago by the company, are reported to offer distinctive eye-appeal with maximum economy. The Shrimpburger series (Set No. 4) also includes specialty vignettes for crab cakes, cod cakes, or any fish patties.

◆ ◆ ◆

A new high in **fast and accurate heat control for food processing equipment** operating on 236 volt lines is claimed for its new switch control by Proctor Electric Co., Philadelphia, Pa. Capable of boosting a cold heating element to a preselected operating temperature in a matter of seconds, the Proctor In-

(Continued on page 38)

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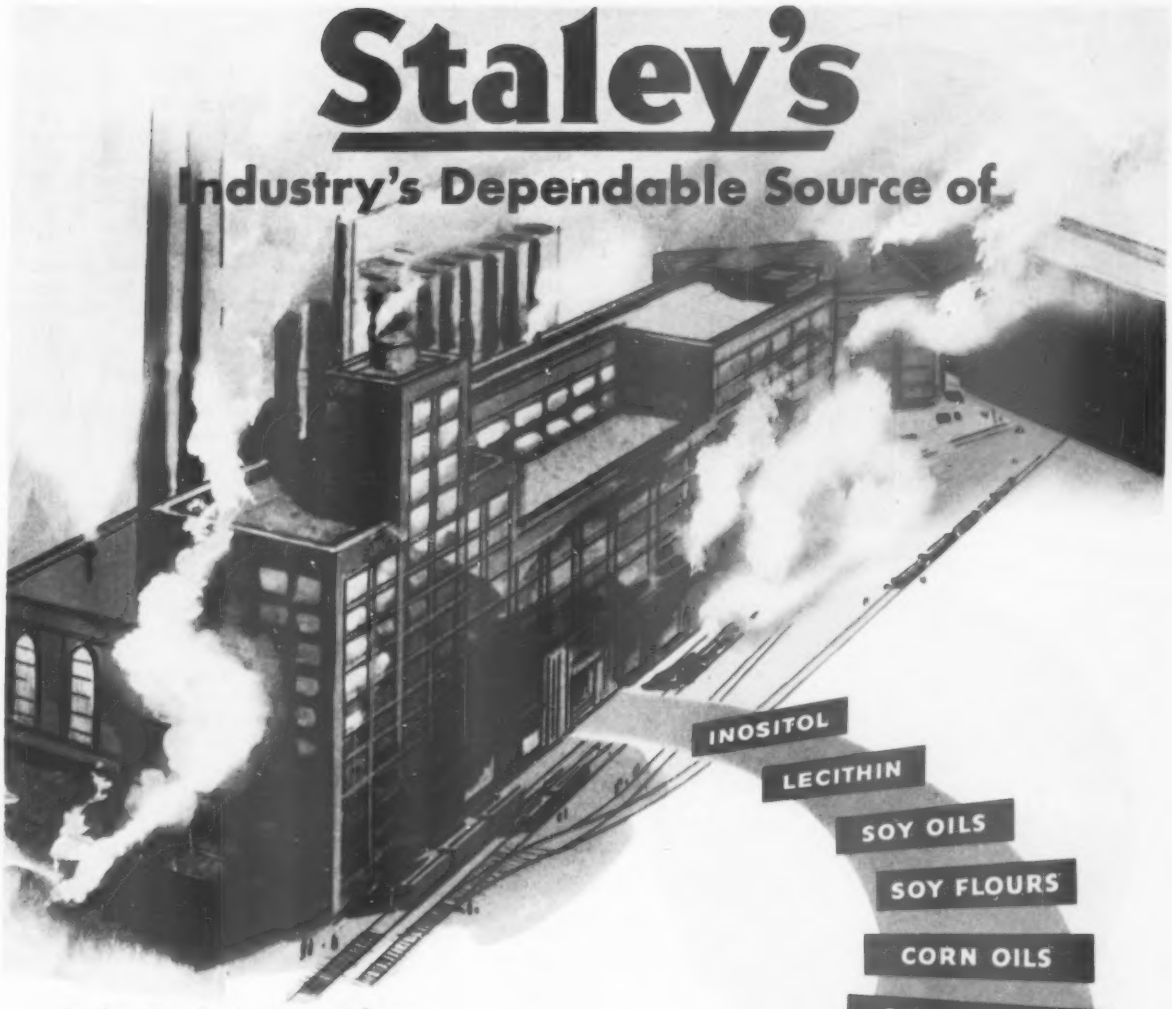

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- Adhesives
- Building Materials
- Tobacco
- Textile
- Pharmaceutical
- Asphalt
- Batteries
- Brewing
- Linoleum
- Leather
- Paint
- Baking

PRODUCTS FROM CORN **Staley's** AND SOYBEANS

for more information, write to the Industrial Division

A. E. STALEY MFG. CO., DECATUR, ILLINOIS

FOOD INDUSTRY TOPICS

(Continued from page 36)

finite Control Flasher Switch Model 504 also incorporates an additional feature whereby the instant the selected electrical input is reached, the switch automatically changes connections to maintain a constant heat level at a lower voltage.

◆ ◆ ◆

NeoFloor is a new, economical, and easily applied **skid-proof surface coating for concrete, wood, and metal floors,** reports Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia 7, Pa. Consisting of a grit-like material anchored in a matrix of resilient neoprene and bonded firmly to the floor with an adhesive primer, NeoFloor is designed for use in plants, shops, laboratories, and other places where oils, greases, and chemicals create safety hazards and maintenance problems. Both primer and coating are applied easily with brush or roller.

◆ ◆ ◆

A new line of plastic hoses and pipes, which, company officials say, is **chemically inert to highly corrosive liquids,** has recently been put on the market by Resistoflex Corp., Belleville, N. J. In addition, the new "Fluoroflex"-T plastic products, made from DuPont's fluorocarbon resin "Teflon," are light in weight and resistant to high and low temperature extremes.

◆ ◆ ◆

A tandem cup pan cleaning and greasing machine that takes the work out of cleaning and greasing "brown and serve" bun, muffin, and cupcake pans is offered by Imperial Machine Co., 925 N. Darien St., Philadelphia 23, Pa. The machine permits an operator to clean and grease twelve 24-unit pans in the same time required to grease one 24-unit pan by hand. The Imperial unit is made largely of stainless steel and is portable to permit easy movement to bakery production lines.

. . . *the literary corner*

A new stepless, adjustable-speed drive, the Electronic Select-A-Spede, made by Louis Allis Co., Milwaukee, Wis., is described in the company's Bulletin No. 1500. Designed for operation from A.C. power lines and available with D.C. drive motors in standard NEMA frame sizes, ¾ to 15 h.p., the device is reported to provide 4 important advantages: (1) precision speed control, (2) unusually wide speed range where required, (3) adaptability to a variety of optional electrical and mechanical modifications, and (4) use of new, simple, reliable electronic circuits.

◆ ◆ ◆

How to measure the viscosity of catsup as a basis for control of the finished product is explained in a new application engineering data sheet (AED 200-21), released by The Foxboro Co., Foxboro, Mass., manufacturer of instruments for the measurement and control of industrial process variables. The system consists of a Brookfield Viscometran viscometer which continuously measures catsup viscosity in a sample chamber at the finishing kettle. This direct measurement, made without interrupting the process, is transmitted to a Foxboro Capacity Dynalog Recorder, which records on a circular chart. A temperature bulb in the sampling line provides for a continuous record of temperature on the same chart.

◆ ◆ ◆

The *Chemical Digest*, published quarterly by Foster D. Snell, Inc., 29 W. 15th St., New York City, and one of the first technical industrial house organs, recently celebrated publication of its twentieth volume. The publication is available without charge to persons interested in new research developments.

◆ ◆ ◆

Three bulletins are in hand from the Industrial Division of Minneapolis-Honeywell Regulator Co., Wayne and Windrim

(Continued on page 40)

Why the big surge in low calorie foods?

One word tells the story – SUCARYL®

(CYCLAMATE, ABBOTT)

Here's your new market—36,000,000 overweight and diabetics—people who won't (or can't) eat regular sugar-sweetened foods.

Here's how you get it—Use SUCARYL to make the most of the low-calorie market. The timing is perfect. Here are a few check points on SUCARYL itself:

SUCARYL gives sweetness without calories. With all its full, clean sweetness, SUCARYL has no nutritive content. Dieters can have all the sweetness they want with SUCARYL... and never add a calorie.

SUCARYL has no bitter after-taste. To dieters who have tried synthetically sweetened products, this is point number one. SUCARYL tastes just like sugar. Food products that are sweetened with SUCARYL have no give-away "off" taste.

SUCARYL is known to millions. Magazine and newspaper publicity is big on SUCARYL. The public knows the name. They're using SUCARYL now in their homes.

What's in it for YOU? A bigger-than-ever market for dietetic products... with volume going up and up every month. You can sell this market now. Write today for further information to Chemical Sales Division, Abbott Laboratories, North Chicago, Illinois.

Abbott

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	Dehydrated Soups	Ice Cream Stabilizers
	Dessert Mixes	Marshmallow Toppings
	Flavoring Emulsions	Meringues
Aspics	French Dressing	Milk Puddings
Beer	Frozen Fish	Pie Fillings (Dry)
Beverages	Frozen Fresh Fruit	Pumpkin Pie Filling
Cake Icings	Frozen Fruit Juices	Ripple Ice Cream Syrup
Canned Fruit	Fruit Fillings (Pie)	Sauces (Prepared)
Cheese Spreads	Fruit Juices	Sherbet Stabilizers
Chocolate Milk	Fruit Pie Fillings	Soups
Chocolate Syrups	(canned, ready-to-serve)	Syrups
Confectionery	Gas Whipped Cream	Water Gel Desserts

..AND YOUR IMPROVEMENT PROBLEM HERE?

- ☐ Binding
- ☐ Bodying
- ☐ Emulsifying
- ☐ Gelling
- ☐ Modifying
- ☐ Stabilizing
- ☐ Suspending
- ☐ Thickening
- ☐ Custardizing milk & products containing milk solids
- ☐ Improving mouth-feel and flavor
- ☐ Increasing efficiency of component ingredients
- ☐ Modifying ice crystal growth
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THEN YOU'LL FIND YOUR ANSWER HERE!

*SeaKem is the trademark for the standardized, water-soluble, sea plant extractives manufactured by the Seaplant Chemical Corporation. Refined by rigidly controlled processes which insure dependable uniformity and purity, SeaKem "Colloids Out of the Sea" are light amber to colorless, free-flowing flaky powders. Available in a variety of types suitable for use in an unusually wide range of food applications (see lists above), SeaKem Products have won acceptance on the basis of proven advantages with leading manufacturers and processors.

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Whether your problem is an old story or "different from anyone else's", chances are SeaKem "Colloids Out of the Sea" and Seaplant Chemical's confidential laboratory service, can mean time and money to you. Fill out and mail coupon today for prompt attention.

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Serving Industry with "Colloids Out of the Sea"

SEAPLANT CHEMICAL CORPORATION
63 David St., New Bedford, Massachusetts

FOOD INDUSTRY TOPICS

(Continued from page 38)

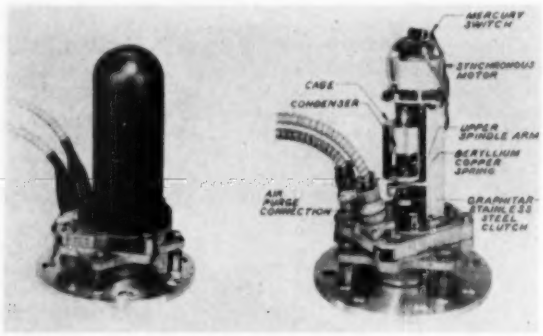
Aves., Philadelphia 44, Pa. Bulletin 6401 describes and illustrates a moderate cost **pneumatic thermometer controller.** Bulletin 8930, on **Fixed and Adjustable Indexet Mechanisms,** describes construction, operation, and applications of these pneumatic remote index setting devices. Twelve-page Bulletin 362 describes the high quality, low cost Series 362 line of **diaphragm motor valves** for on-off or narrow band proportional control. To obtain this literature, write to Station 64 at the address as given above.

◆ ◆ ◆

From Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., comes news of a completely new line of flavors—**Dry Soluble Seasonings**—for whose manufacture and development D & O has built a large new plant in Hawthorne, N. J., employed a special technical staff, and installed a new pilot plant operation at the company's New York laboratories. Ample details are given in the February 1954 issue of the *D & O News.*

◆ ◆ ◆

An illustrated brochure describes the Viscometran, a flexible and rugged industrial instrument which provides accurate and continuous **viscosity measurement of materials in process.** Manufactured by Brookfield Engineering Laboratories, Stoughton, Mass., the Viscometran has already performed successfully un-



Viscometran with cover in position (left) and removed.

der a variety of difficult corrosion and temperature conditions with such products as catsup, paper coatings, starch (conversion process and homogenization), glues, paint solutions, catalyst slurries, crystal slurries, polyvinyl acetate solutions, and flour-water mixtures. For a copy of the brochure write Mr. R. A. Minard, Technical Applications, Brookfield Engineering Laboratories, Inc., 240 Cushing St., Stoughton, Mass.

◆ ◆ ◆

A new "Speedy-Kit" for fast, sensitive **field testing of water hardness** has been announced by Calgon, Inc., and Hagan Corp., Pittsburgh, and is described in Bulletin 5RE54, available free upon request from Calgon, Hagan, or the Buromin Co., P. O. Box 1346, Pittsburgh, Pa. The simplified test employed with the Speedy-Kit is expected to be of special value to home economists and laboratory technicians among others in making routine water hardness checks.

◆ ◆ ◆

Its standard line of **agitated kettles**—including autoclaves, hydrogenators, mixers, neutralizers, polymerizers, reactors, sulfonators—is featured in a new free brochure just issued by The Colonial Iron Works Co., 17643 St. Clair Ave., Cleveland 10, O. Kettles are available in metals ranging from aluminum to stainless steel and in all pressure ratings based on fixed outside shell diameters in code and non-code construction. Also available is a full range of horizontal, vertical, and double-motion drives.

The properties that make **glycerine** the material of choice in conditioning toilet goods, pharmaceuticals, foods, confections, films, fibers, and other personal and industrial products are outlined in a new free 20-page booklet, "Glycerine—Preferred for Product Conditioning," published by the Glycerine Producers' Assn., 295 Madison Ave., New York 17, N. Y. In the booklet, glycerine is compared with other materials used as conditioners, physical data being given in the form of charts and tables where appropriate. Applications of glycerine as a conditioner in given fields are considered in detail.

◆ ◆ ◆

A new, patented **spot fumigant,** in combination with a new spot fumigant applicator, has just been announced in a bulletin issued by Ferguson Fumigants, Inc., Ferguson 21, Mo. The new fumigant is a patented mixture which is claimed to possess a high degree of synergism. Application is made through quarter-inch holes, pre-bored in cereal handling and processing equipment, through use of a portable machine. The machine is activated by air pressure, and delivers a pre-set dosage through a hundred-foot length of plastic tubing each time a button on the machine is depressed. Cost reduction in both material and labor for effective spot fumigation is claimed.

◆ ◆ ◆

A free bulletin describing a 10-service **automatic control panel board "package"** for the process and allied industries is available from the J. P. O'Donnell Corp., Instrument Division, 39 Broadway, New York 6, N. Y. Included in the arrangement are standard, semi-graphic, and graphic control boards.

. . . *meeting hall and conference room*

Speaking at the **23rd annual sales meeting of Magnus, Mabee and Reynard, Inc.,** held in New York City on February 10, Mr. Percy C. Magnus, president, predicted a steady advance in the company's world-wide business during 1954. "As the present year matures," he stated, "business will be as good or as bad as we make it. There is no reason why, with careful planning and follow-through, American industry and business cannot duplicate the peak performance of 1953 and perhaps surpass it. This is no time for thoughts of recession or depression. The same amount of effect can be better applied to preaching optimism and emphasizing the growth and potentialities of business as they actually prevail." Further expressions of optimism were added by vice presidents J. B. Magnus and R. B. Magnus.

While on the subject of MM&R, it should be mentioned that the firm has recently issued an impressive new catalog of information on its products, prices, and policies. The catalogue will be published three times yearly and mailed to interested purchasing agents and others. The company welcomes requests for inclusion on its mailing list. Write MM&R at 16 Desbrosses St., New York 13, N. Y., or 221 N. La Salle St., Chicago 1, Ill.

◆ ◆ ◆

Right-e-oh! Here we go to the Land Down Under and the **1954 annual meeting of the Australian IFT (Northern Section).** The time—May 26 to 29. The place—the Ritz Hotel, Leura, New South Wales. The order of business will include technical papers, a short Symposium on Quality Control, and a brief Symposium on Packaging.

◆ ◆ ◆

The **sugar industry** came in for major attention at the international meeting of The American Society of Mechanical Engineers in Mexico City, March 10-12, with seven papers devoted to problems of sugar processing. The three-day meeting began with a speech of welcome by Sr. Adolfo Ruiz Cortines, President of the Republic of Mexico. Response to the President's greeting was presented by Mr. Lewis K. Silleox, ASME president. Approximately 300 ASME members, accompanied by friends and members of their families, attended the meeting.

◆ ◆ ◆

Profit—the key problem confronting the candy industry today because increased ingredient and production costs have affected profits adversely—will be analyzed from every angle at

REVOLUTIONARY NEW CLEANING METHOD FOR HIGH TEMPERATURE EQUIPMENT

Chelation AND WHAT IT MEANS TO YOU IN SAVINGS

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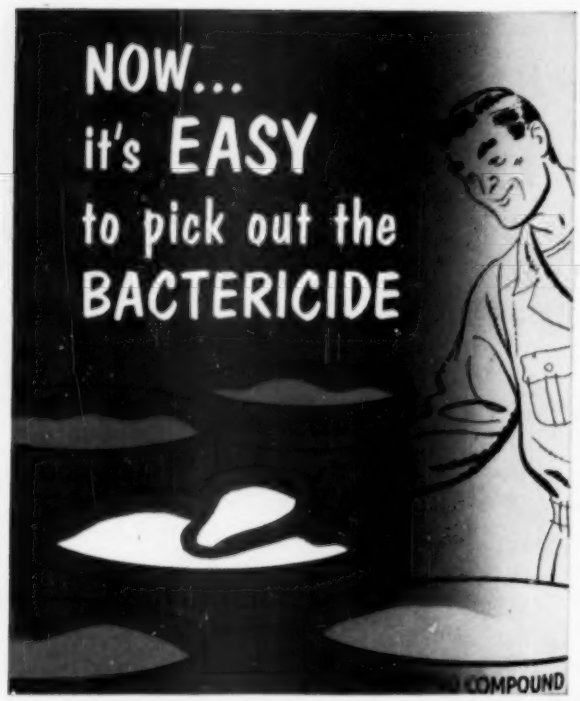

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FOOD INDUSTRY TOPICS

the 71st **Annual Convention of the National Confectioners' Association,** to be held at the Conrad Hilton Hotel, June 6-10, according to Mr. Victor H. Gies, Mars, Inc., and Mr. Robert B. Schnering, Curtiss Candy Co., chairman and co-chairman respectively of the program committee. Tieing in with the "Planning for Profit" theme will be the 28th Annual Confectionery Industries Exposition, which is to be the largest and most comprehensive ever held by the candy industry. Latest developments in ingredients, machinery, equipment, packaging supplies, and services will be on display in the Hilton's Main and North Exhibition Halls. Mr. David P. O'Connor, Penick & Ford, Ltd., Inc., is chairman of the exposition committee.

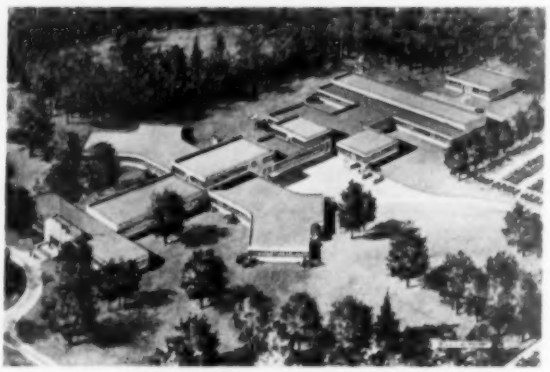
◆ ◆ ◆

The **Society of Flavor Chemists** held their first regular meeting on February 1, with representatives of most of the leading suppliers of basic flavoring materials present. While the purpose of the organization is primarily social, occasionally informal talks on matters of mutual interest will be arranged. Mr. Jack Bouton was elected temporary chairman at this meeting. Those interested in the group may contact him at Synfleur Laboratories, Monticello, N. Y.

◆ ◆ ◆

A final reminder to members of The Refrigeration Research Foundation and others planning to attend the **TRRF annual meeting** at Boca Raton, Fla., the end of April. An important part of the usual annual meeting will not take place at Boca Raton but at the Edgewater Beach Hotel, Chicago, where, on April 21 and 22 there will be held a Refrigerated Warehousing Workshop featuring a comprehensive, detailed discussion of the research that has made and is making the refrigerated warehousing industry and allied industries. The Foundation membership meeting will take place in Boca Raton on April 25, and the Board of Governors will meet at dinner on April 26.

. . . *building up and branching out*



Canco's new Research and Development Center (drawing).

American Can Company has announced the breaking of ground on a 40-acre tract of land in Barrington, Ill., for the construction of its new **Research and Development Center** which it is estimated will be completed in 12 months. According to present plans, the new laboratory will contain approximately 102,000 square feet of floor space and will provide for expansion, now envisaged, to a floor area of about 140,000 square feet. In addition to administrative offices, the building will contain special laboratories devoted to food chemistry and nutrition, tinplate, coatings, and other specialized types of research. Special "hot" and "cold" rooms, capable of simulating climate conditions from the tropics to the Arctic, will permit storage of test packs of every type of food and non-food products. One of Canco's most important long range research projects—known as "Operation Survival"—will be continued in the new center. The goal of this project is to eliminate tin as a can-making material. The center will initially house a staff of more than 150 scientific, technical, clerical, and maintenance people. Head of

the new Barrington laboratory will be Dr. Robert Warren Pilcher, the can company's director of research.

◆ ◆ ◆

The start of construction by Atlas Powder Co., Wilmington, Del., of **two new plants** which will greatly increase the firm's capacity to produce the Atmul and Atmos mono- and diglycerides and other emulsifiers which it supplies to the food industry, was announced by Mr. Kenneth E. Mulford, general manager of the Chemicals Department. The larger of the two plants, at Memphis, Tenn., will cost more than $1,000,000, and is scheduled for completion by late 1954. The second plant, at Brantford, Ont., is being erected by Atlas Powder Co., Canada, Ltd. Its first unit, to cost about $350,000, will be in operation within six months. Preliminary planning has been started, looking to the addition of a second unit for the production of ethylene oxide derivatives at this location. The Memphis and Brantford plants will produce emulsifiers for the food, baking, ice cream, and candy industries.

Establishment of the new **Food Industry Division** reflects Atlas's recognition of the growing importance of chemistry in improving the nation's food and of the need for a separate division within the Chemicals Department to meet the specialized requirements of food processors. The new Division will be under the general supervision of Mr. Wm. W. Hays, assistant to the general manager of the Chemicals Department.

. . . *the human element*

Following the merger of Wallace & Tiernan Co., Inc., and Novadel-Agene Corporation to form Wallace & Tiernan, Inc., it was announced by Mr. M. F. Tiernan, board chairman, that **Mr. F. G. Merckel** had been elected president, **Mr. R. M. Jackson** executive vice president, and **Mr. G. D. Peet** vice president in charge of product engineering and development.

(Continued on page 44)

Trutaste flavors!

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Ac'cent is monosodium glutamate in its purest form: convenient, uniform crystals. The natural glutamic acid present in all foods dissipates in shipping, storage and processing. Ac'cent is the pure sodium salt of glutamic acid, vital in retaining nature's original flavor in food. Ac'cent adds *no* flavor of its own.

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PURE MONOSODIUM GLUTAMATE

...makes processed food taste better!

AMINO PRODUCTS Division of International Minerals & Chemical Corporation, 20 North Wacker Drive, Chicago 6, Ill.

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FOOD INDUSTRY TOPICS

(Continued from page 43)

Appointment of **Mr. Fred M. Belcove,** who has had experience in the food and chemical industries, to the company's Chicago sales organization has been announced by Mr. Wm. Lakritz, president of Florasynth Laboratories, Inc., New York City.

◆ ◆ ◆

Mr. Malcolm M. Coston has been appointed manager of the Process Equipment Division of Rodney Hunt Machine Co., Orange, Mass. He will be responsible

Mr. Coston

for sales and development of the patented TURBA-FILM Evaporator and the Rodney Hunt-Luwa Spray Dryer.

◆ ◆ ◆

Dr. Walter L. Clark has recently been appointed assistant professor of biochemistry in the School of Nutrition at Cornell University, in charge of the program of Food Science. He holds a joint appointment in the Department of Biochemistry and Nutrition of the College of Agriculture, acting as faculty adviser for food processing students and teaching a course on the food industry.

EMPLOYMENT NOTICES

AVAILABLE: Ph.D. Food Technology, Bacteriology, Chemistry. Age 30. June graduate. Background in industrial relations and management. Leadership potential. Desires responsible position with progressive organization. REPLY BOX 320, Institute of Food Technologists, 176 W. Adams Street, Chicago 3, Ill.

WANTED: Oil Chemist with experience in administering research on salad dressing, margarine and oils by leading food manufacturer to head up research section. Location, Middlewest. REPLY BOX 323, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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If you pack peas and are looking for ways to cut costs, see what this specially engineered FMC pea equipment can do for you. First, each item is engineered to do an exacting job continuously and automatically. This greatly simplifies operations, speeds up output, and frequently reduces manpower requirements. Secondly, this equipment is sturdily constructed of high-grade materials—precision-built to run smoothly and efficiently through extended heavy-load periods with a minimum maintenance factor. And thirdly, its outstanding design, developed over many years, provides the gentle handling essential in maintaining the high quality established by the canner for his finished product.

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1 FMC 8-STATION PEA & BEAN FILLER
Automatically measures and fills the product, then adds brine to a highly accurate measure. Handles up to 180 CPM, depending on can size.

2 FMC TWIN REEL PEA GRADER
Features patented FMC "Cloverleaf" screen for increased output, more accurate sizing without damage to peas. Supplied with any number of sections desired.

3 KEY FROTH FLOTATION CLEANER
Designed for selective and automatic separation of waste and foreign material from the product. Unmatched efficiency at a capacity up to 8,000 pounds of peas per hour.

4 FMC 15 STATION PEA & BEAN FILLER
New and unique in design, these twin units achieve a rare combination of accuracy plus high capacity (up to 380 CPM—211 x 304) with their carefully calibrated measuring pockets and overflow briner principle.

5 FMC BLANCHER
Available in 8 to 18 ft. sizes, according to length of blanch required. Has highest capacity per floor space, is easy to install and clean, and is economical in steam and power requirements.

6 FMC ROTARY PEA WASHER
Extremely simple and effective, smooth in operation, absolutely sanitary and easy to clean. Pressure lubrication gives long, trouble-free bearing life. Handles peas and many other products.

7 FMC GOOSENECK CONVEYOR
Positive interlocking buckets form continuous conveyor with large capacity for peas, beans and other granular products. Built in any even-foot length.

8 FMC (LEWIS) QUALITY GRADER
Efficient separation of two grades of peas, sinkers and floaters, through the specific gravity principle. Triple-reel discharge thoroughly separates peas from brine and trash.

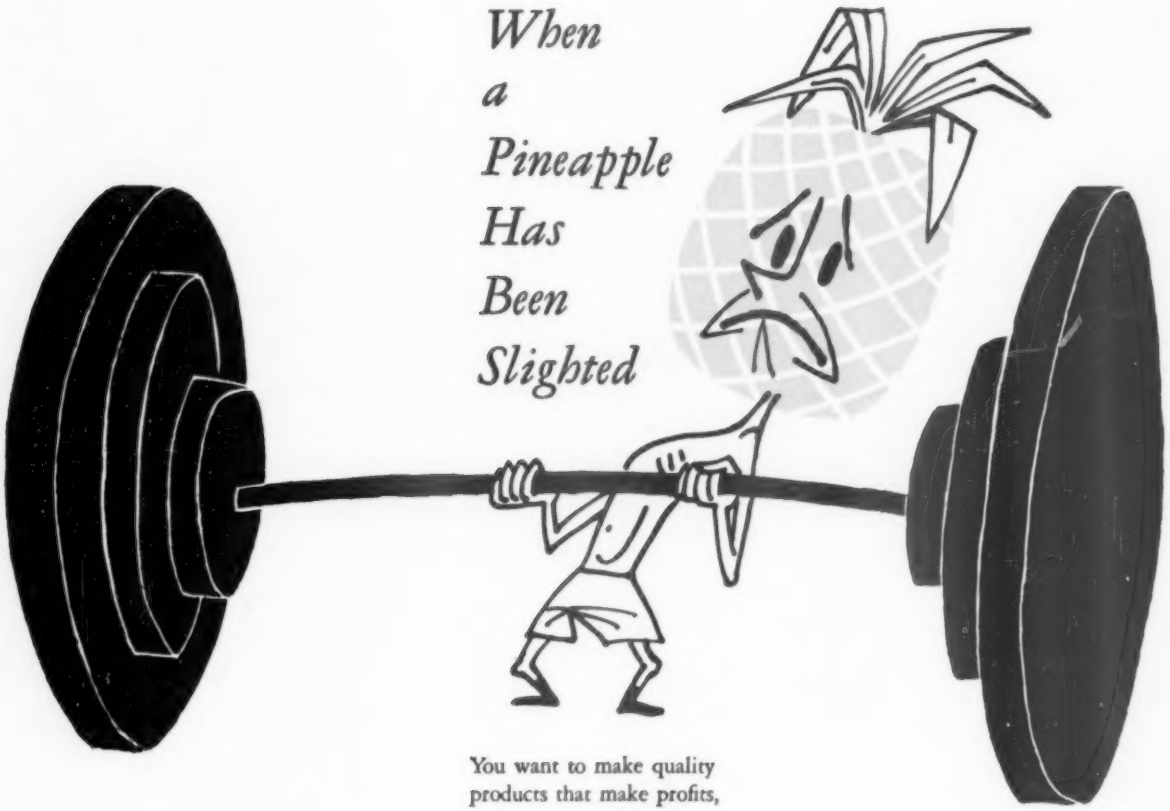
FOOD MACHINERY AND CHEMICAL CORPORATION

Canning Machinery Division

General Sales Offices:

WESTERN: SAN JOSE, CALIFORNIA **EASTERN:** HOOPESTON, ILLINOIS

When a Pineapple Has Been Slighted



You want to make quality products that make profits, and that's just about the whole story. Sometimes it's a difficult job.

There's a good way to do it.

Use Norda Flavors.

Use Norda genuine natural fruit Flavors, rich with true fruit goodness. Combine them—"piece them out"— maybe strengthen them—with Norda imitation fruit flavors, whose characteristics, taste, and aroma duplicate and supplement all the richness of actual fruit.

Try it, for instance, with Norda Pineapple, both genuine and imitation. You'll improve the "eating pleasure" your products give. You'll sell more, and save more, and make more.

Send for free "taste, test, try" samples today.

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